Prevalence of overweight and obesity among 6-13 year old Kuwaiti school children: secular trends, risk factors and their implications

Hasan Faleh Sanam Alshammari

School of Biosciences

Prevalence of Overweight and Obesity among 6 – 13 Year Old Kuwaiti School Children: Secular Trends, Risk Factors and Their Implications

By

Hasan Faleh Sanam Alshammari

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Abstract

Evidence of childhood obesity as a strong predictor of risk of non-communicable diseases has been accumulating world wide over the last three decades. The focus of this study was to provide a cross-sectional picture of the influence of the demographic and epidemiological transition on health habits, lifestyle changes, dietary patterns and obesity risk among 6 – 13 year old Kuwaiti school children. A sample of 1536 Kuwaiti school children was recruited in 2001 through a multi-stage cluster and stratified sampling technique to investigate the impact of these environmental factors. The study design included administration of a structured and pretested socio-demographic, health habits and lifestyle questionnaire. Of these a sub-sample of 224 ramdomly selected subjects (>14% of total) (with a response rate of 86.6% n=194) undertook a 7-day dietary intake and physical activity record and anthropometric measurements. Some biochemical indices of nutritional risk were further assessed among 224 of eligible subjects (mean age 10.3 ±2.4 yrs; response rate 50.9%, n=114) in 2003. Findings from this study confirm the presence of high income and increased food availability and choice the consequences of which included intake of high energy, high fat, sugar and salt-based diets (above recommended intakes) coupled with a sedentary lifestyle with low levels of daily total energy expenditure. Positive energy balance was confirmed by evidence of overweight and obesity (>65% above 85^{th} percentile for BMI cut-off of 25 kgm^{-2}) with at least 21% obese (above 95^{th} percentile i.e. BMI 30 kg/m^2), increased ΣSFT and increased WHR. Furthermore, biochemical evidence of the nutritional risk was found with high levels of serum fasting glucose, total triacylglycerols and total cholesterol levels associated with low HDL-c levels, the latter further supporting the notion that their levels of physical activity were low (mean physical activity level PAL of 1.29 ±0.13). The biochemical indices suggest that nearly 15% of subjects were at risk of the metabolic complications. These findings also evidenced by increasing trends of obesity over the last two decades in a similar age-matched cohort suggest the presence of a nutritional transition with potentially serious health consequences. This provides opportunities for action and implementation of new nutrition and public health actions to avert any health crisis in this population. A strategic framework for intervention involving school-based nutrition and health promotion, community, family and stakeholder participation and government policy reviews and interventions have been proposed as a medium to long term solution.

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List of Abbreviations

Aver	average
BIA	multi-frequency bioelectrical impedance analysis
BMI	body mass index
BMR	basal metabolic rate
Ca	calcium
CDC	U.S. Centers for Disease Control and Prevention
CHD	coronary heart disease
CHF	congestive heart failure
CI	confidence interval
cm	centimeter
COMA	Committee on Medical Aspects of Food Policy
CT	computed tomography (or computerized tomography)
CVD	cardiovascular disease
d	day
DEXA	dual energy Xray absorptiometer
DHHS	U.S. Department of Health and Human Services
dL	decilitre
DLW	doubly labeled water technique
DRIs	Dietary Reference Intakes
DRV	Dietary Reference Value.
EAR	Estimated Average Requirement
EI	energy intake or food energy
Fe	iron
FFM	fat-free mass
g	gram
GERD	gastroesophageal reflux disease
Glu	glucose
H	height
Hb	haemoglobin
HDL-c	high-density lipoprotein cholesterol

HFSS	High in Fat, Sugar and Salt
Hg	Mercury
hr	hour
hrs	hours
INQ	Index of Nutritional Quality
IOTF	International Obesity Task Force
J	joule
kcal	kilocalorie
KD	Kuwaiti Dinar
KFC	Kentucky Fried Chicken
kg	kilogram
KIMS	Kuwait Institute for Medical Specialization Studies and Research
kJ	kilojoule
L	litre
LDL-c	low-density lipoprotein cholesterol
LRNI	Lower Reference Nutrient Intake
M	mean
McD	McDonald
mg	milligram
µg	microgram
Mg	magnesium
MJ	megajoule
mmol	millimol
MRI	Magnetic resonance imaging
N	number
NAO	National Audit Office of United Kingdom
ng	nanogram
NCHS	U.S. National Center for Health Statistics
NHANES	National Health and Nutrition Examination Survey
NHIS	National Health Information Survey
NIDDM	Non-insulin-dependent-diabetes mellitus

NIH	National Institute of Health
NHMRC	National Health and Medical Research Council
PAL	physical activity level
PAR	physical activity ratio
Percent (%) BF	percentage of body fat
PUF	polyunsaturated fatty acid
r^2	correlation co-efficient
R-BMIFA	Relative BMI for age
RDAs	Recommended Daily Amounts (recommended dietary allowances)
RDI	Recommended Daily Intake
RE	retinol equivalent
R-HFA	relative height for age
RNI	Reference Nutrient Intake
R-WFA	relative weight for age
SCFE	slipped capital femoral epiphysis
SD	standard deviation
SeDS	Sedentary Death Syndrome
SEM	standard error mean
SF	saturated fatty acid
SFT	skinfold thickness
SI	safe intake of a nutrient.
SPSS	statistical package for social science research
SSSF	subscapular skinfold
Sterling (£)	Pound
TBW	total body water
TC	total cholesterol
TEE	total energy expenditure
TF	total fat
TG	triglyceride
TSF	triceps skinfold thickness
TV	Television

UK	United Kingdom
USA	United States of America
W	weight
WHO	World Health Organization
WHR	waist to hip ratio
yrs	years

Supports to Calculation

Energy units

1 kilocalorie (kcal) = 10^3 calories = 4.18 kilojoules (kJ)

1 kilojoule (kJ) = 10^3 joules = 0.24 kcal

1 megajoule (MJ) = 10^6 joules (J)

1 gram (g) carbohydrate = 4 kcal = 17 kJ

1 gram (g) protein = 4 kcal = 17 kJ

1 gram (g) fat = 9 kcal = 37 kJ

Weight

1 ounce (oz) = approximately 28.4 grams (g)

1 pound (Ib) = 16 ounces or 454 g

1 kilogram (kg) = 10^3 g or 2.2 Ib

1 gram (g) = 10^3 milligrams (mg)

1 milligram (mg) = 10^3 micrograms (μg)

Length

1 inch (in) = 2.54 centimetres (cm)

1 meter (m) = 100 cm or 39.37 inches

1 foot (ft) = 30.48 cm

Volume

1 litre (L) = 1000 millilitres (ml)

1 decilitre (dL) = 10^{-1} liter or 100 millilitres

1 millilitre (ml) = 0.03 fluid ounces

1 gallon = 3.79 litres

1 cup (c) = 8 fluid ounces

1 teaspoon (tsp) = about 5 g or 5 ml

1 tablespoon (tbs) = 3 teaspoons (tsp) or 15 millilitres

16 tablespoons = 1 cup

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CHAPTER 1.0 Introduction

1.1 Obesity phenomenon

Obesity is a major global public health problem and is increasingly being seen among populations in both developing and industrialised countries. Evidence for this growing trend has been reported widely (WHO 1998, 2000, 2002) and underscore the epidemiological and nutritional transitions which have accompanied the shift in economic fortunes and incomes of populations across different continents.

Obesity refers specifically to having an unusually high proportion of body fat or adipose tissue in relation to lean muscle mass. Industrialisation, urbanisation, economic development and market globalisation may have led to changes in the dietary and lifestyle patterns of people the world over leading to the emergence of obesity and diet-related, chronic, non-communicable diseases (NCDs), which are taking over from the more traditional under nutrition and infectious diseases as causes of morbidity and mortality (Moussa, 2004; Suàrez-Herrera, 2006).

Evidence for this epidemiological transition is reflected in the shifts in disease types, patterns, morbidity and mortality. For instance in Chile, which has seen its per capita Gross National Product (GNP) doubled over the last two decades, there has been a dramatic reduction in infant mortality rate to less that 10 per 1000 Live Births (compared to the regional average of 35.7 per 1000 live births) whilst over the same period, the prevalence of non-communicable diseases, particularly cardiovascular disease has increased from 54% in 1970 to over 75% in 1998 (Kain *et al*, 2002).

The trends in obesity mentioned above have been observed in many countries in economic and nutritional transition, particularly the Arab Peninsula region where income levels have risen dramatically over the last few decades (Must *et al.*, 1999; National Task Force on the Prevention and Treatment of Obesity, 2000; Al Isa & Moussa, 2000; Bartrina *et al.*, 2006). Countries in the region are faced with the double-burden of disease, having to tackle traditional communicable as well as life-style related NCDs including cardio vascular disease (CVD), diabetes mellitus, hypertension and some cancers associated with obesity

(Abdella *et al.*, 1996; Al Khawari *et al.*, 1997; Saleh *et al.*, 2000; El-Hazmi & Warsy, 2001).

1.2 Obesity: Impact and Cost

Obesity has an extensive impact on personal health with repercussions for the quality of life, having a direct impact on disability adjusted life years. Its associated risks to other diseases and syndromes (co-morbidities) are well reported, and its impact on family and public health care costs cannot be over-emphasised. Of particular note and interest are its association with insulin resistance, dyslipidaemia, high blood pressure and glucose intolerance (the metabolic syndrome or syndrome X) all of which are associated with risk of type 2 diabetes mellitus and ischaemic heart disease (Berenson *et al.*, 1998; Klein *et al.*, 2004; Malekzadeh *et al.*, 2005). Furthermore, obesity increases the risk of orthopaedic complications, respiratory problems, secondary infertility problems and psychosocial consequences in the form of a negative self-image, emotional, social and behavioural problems, and depression (Seidell, 1995; Wolf & Colditz, 1996; Renders *et al.*, 2004).

Of late, not only adults but also children and adolescents are falling victims to obesity. The words "pandemic" and "epidemic" have been used to describe the recent dramatic upward trends in child, and adolescent overweight and obesity, (Kimm and Obarzanek, 2002; and Chopra *et al.*, 2002). Obese children and adolescents may have a range of medical conditions including dyslipidaemia and type-2 diabetes. Other problems, such as musculoskeletal discomfort, obstructive sleep apnoea, heat intolerance, asthma and shortness of breath, greatly affect their lifestyle (Must *et al.*, 1999) and present a serious challenge for parents, governments and those concerned with public health.

In economic terms, the direct and indirect treatment costs of obesity are estimated at £6.6 to 7.4 billion per year in the United Kingdom (Ofcom, 2004). Similarly the economic burden of obesity in the United States is estimated to be between 99 and 117 billion dollars annually (Wolf and Colditz 1998; Thompson and Wolf, 2001). These costs in industrialised countries are likely to be increasingly seen in countries presently in economic transition and many developing countries if present trends continue. No where is this scenario more stark than in the Arab Gulf region where obesity prevalence ranges from 16 to 35 per cent among the populations of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE) (Al Mousa & Parkash, 2000; Al-Haddad *et al.*, 2000; Al-Mahroos & Al-Roomi, 2001; Musaiger, 2004). In these countries obesity among children, adolescents and young adults of both sexes is rapidly on the increase and evidence of the chronic diseases among young people has been reported (Al-Isa, 1997; El-Hazmi & Warsy, 2002; Al Mousa *et al.*, 2003).

1.3 Assessment of childhood obesity

The continuing presence of child-related obesity makes it important that nutritionists and public health researchers be able to assess health and nutritional status by a number of available measurements and examinations. Although arguments about the best means of measuring childhood obesity abound, there is nonetheless a growing consensus about the use of anthropometry as a relatively inexpensive means of measuring nutritional status if carried out by trained individuals. Strictly speaking, factors influencing nutritional status in childhood lend themselves to both qualitative (e.g. estimation of levels of physical activity employing standardised physical activity questionnaires) and quantitative assessments. Indeed, others have blended the use of these measurements with clinical assessments in order to define nutritional risk in individual children which are applicable to any context. A consensus definition of nutritional assessment by U.S. Department of Health and Human Services (DHHS) is as follows: "the measurement of indicators of dietary status and nutrition-related health status to identify the possible occurrence, nature and extent of impaired nutritional status" (Lee & Nieman, 2003). The following paragraphs summarise the commonly employed means of assessing nutritional status in childhood, some of which were selected to undertake measurements in the present study.

- Anthropometry is an important process in assessing nutritional status related for measuring body dimensions and composition (Wood *et al.*, 2003). In large-scale population surveys, BMI, WHR, SFT are commonly used, in spite of the variations and limitations, as a surrogate of more complicated methods to indicate the extent of overweight and for body fat content (Hartz *et al.*, 1983; Dehghan *et al.*, 2005).

- Another important measure is the estimation of dietary intake and physical activity level to estimate energy balance (energy intake vs. energy expenditure). The capability to classify people at nutritional risk and to successfully enhance their physical condition has prepared this assessment a vital tool for health professionals concerned to produce health care as more cost-effective. However, the assessment of nutritional status by using record methods requires encouragement and support.

- Biochemical examinations are also an important measure to ensure the current and future health risks, such as diabetes, anaemia, and a risk of coronary heart disease risk. Biochemical or laboratory methods are used in nutritional assessment including measurements of nutrients or their metabolites in blood, feces, or urine, or measuring a variety of other components in blood and other tissues that have a link to nutritional status. For example, metabolic syndrome or syndrome X is a new concept estimated by using biochemical methods. However, this concept was considered by very rare studies in the local region.

1.4 Environment and socio-economic transition

Evidence for the mechanisms of obesity development is still evolving and presently not fully understood. It is however clear that obesity can occur when energy intake exceeds energy expenditure (NIHCM, 2003; Nestle, 2003) i.e. when a person is continually in a state of positive energy balance. Therefore, any factor which can disturb or shift the balance between the two energy components, i.e. intake vs. expenditure, will over time, affect the health and nutritional status of individuals.

The socio-economic, demographic and epidemiological transitions observed in developing countries (particularly the Arab Gulf region) over the last three decades, raises health concerns among these populations particularly with regard to lifestyle changes and health habits which relate to the modifiable risk factors for obesity and its co-morbidities. This transition makes the environment a major determinant of obesity particularly in countries with rising incomes.

Associated with the socio-economic transition are new health habits and behaviours related to diet, physical activity, and lifestyle. For instance, food has become more affordable to larger numbers of people as the price of food has decreased substantially relative to income. The concept of 'food' has also changed from a means of nourishment to a marker of lifestyle and a source of pleasure and a social event i.e. every meal time is tantamount to a 'feast'. Clearly, the implications of this increased intake of energy are a requirement for increases in physical activity in order to offset the potential for 'chronic' positive energy balance which would lead to overweight and obesity (Styne, 2005).

1.5 Gene-environment-lifestyle interactions

The rapid increase in the incidence of childhood obesity has forced many researchers to study this phenomenon from different angles. Ebbeling *et al.* (2002) and others suggested any factor that raises energy intake or decreases energy expenditure by even a small amount will cause obesity in the long-term although the mechanism of obesity development is not fully understood. Studies of Goodrick *et al.* (1996); Hill & Peters (1998); and Grundy (1998) found that environmental factors and lifestyle preferences play a major role in increasing the prevalence of obesity worldwide. To a little extent, childhood obesity is due to genes, medical causes, or side effects due to drugs like steroids (Montague *et al.*, 1997; Link *et al.*, 2004).

Current scientific evidence suggests that obesity may result from energy imbalance which is multi-factorial and rather complex. These complex factors may be interactive and synergistic and as has been reported and debated following earlier work of Lucas (1991) and others, the underlying risk of obesity and its related co-morbidities like diabetes and heart disease may be inter-generational as occur within a single life cycle. Barker and colleagues proposed the "fetal origins" hypothesis, which posits that poor fetal nutrition causes adaptations that program future propensity to obesity, diabetes and cardiovascular disease (Barker, 1992; Barker *et al.*, 1993; Barker, 1994). More recently, risk factors for clinical conditions including type II diabetes mellitus and hypertension have been shown to exhibit plasticity, the origins of which may be intrauterine growth restriction (IUGR) leading to nutritional programming of memory cells which under the right conditions, express themselves (Lucas *et al.*, 1998; Lucas *et al.*, 1999; Martorell *et al.*, 2001; Harding, 2001; Barker, 2003).

Ells *et al.* (2005) stated that "contrary to a popular misconception, fewer than 1% of childhood obesity cases are directly caused by a genetic disorder". Nevertheless, genetics may form part of a complex interaction with many other environmental and behavioural factors, as illustrated by Bray (2002) who stated that a child's genetic make-up 'loads the gun' while their environment 'pulls the trigger'. This mean that obesity genes are best expressed in appropriate environment (an environment that promotes high energy intake and low physical activity i.e., obesigenic environment) (Allison *et al.*, 1999; Newell *et al.*, 2007). Parsons *et al.* (1999) to identify risk factors for obesity concluded that parental fatness, social factors, birth weight, rate of maturation, genetic predisposition, physical activity, dietary, and other behavioural or psychological factors contributed to the onset of obesity. Whitaker and Dietz (1998) have proposed that prenatal over nutrition might affect lifelong risk of obesity. According to their hypothesis, maternal obesity increases transfer of nutrients across the placenta, inducing permanent changes in appetite, neuroendocrine functioning, or energy metabolism.

1.6 Thrifty phenotype and genotype

The thrifty phenotype and thrifty genotype hypotheses, rather than being contradictory, are best seen as complementary. The simple definition for the relationship between genotype and phenotype is that the genotype codes for the phenotype. The thrifty genotype hypothesis can account for selection over many generations, and hence population differences in susceptibility to clinical conditions (e.g. type II diabetes), whereas the thrifty phenotype hypothesis lends itself to individual adaptations within a lifespan (Poulsen *et al.*, 1997; Lindsay *et al.*, 2000a; Lindsay *et al.*, 2000b). Despite populations differing in the prevalence of type II diabetes, its incidence appears to be closely related to the environmental conditions of westernisation with rapid increases occurring within a generation (Hales, 1997; Tataranni *et al.*, 2000; Lindsay *et al.*, 2000b; Prentice, 2001; Bener, 2005).

Several lines of evidence support the premise that genetic factors alone cannot explain the demographic and ethnic variations in overweight and obesity prevalence. According to Sobal & Stunkard (1989); and Kumanyika (1994) there is a difference in obesity prevalence among low and high-income white women in industrialised societies. Other studies of populations, including migration studies, have shown an increase in average body weight in those who move from a traditional to a Westernised environment (Kawate *et al.*, 1979; Kawate *et al.*, 1980; Ravussin *et al.*, 1994). According to Popkin & Udry (1998) immigrants' offspring continuing to live in USA develop even higher rates of obesity than their parents. More recent studies in Brazil have also documented the coexistence of underweight and overweight within the same family (Florencio *et al.*, 2001), which implies that environmental factors rather than genetics are concerned.

Overall, genetic factors may have an effect on individual predisposition; however, rising prevalence rates indicate that environmental and perhaps, perinatal factors must underlie the childhood obesity epidemic (Ebbeling *et al.*, 2002). At present, environmental conditions for obesity expression are being created in Kuwait and other affluent Arabian Peninsula countries. These conditions need to be ascertained in order to provide evidences from different ways that environment factors are likely to be responsible for the fast rising trends of obesity.

1.7 Obesity: The Middle East context

Data on obesity in the Arabian Peninsula, located in the Middle East region, showed that the prevalence rate among adults is the highest in the world (Al-Isa, 1995; Al-Mannai *et al.*, 1996; Al-Nuaim *et al.*, 1997; Al-Isa, 1997; Moussa *et al.*, 1999; Al-Mahroos & Al-Roomi, 2001). However, the proportion of obesity varies from country to country and between geographical areas within a country (Musaiger, 2004).

In Arabian populations, obesity represents a major threat to health and quality of life (Binhemd *et al.*, 1991; Al-Shammari *et al.*, 1994a; Al-Mahroos & Al-Roomi, 1999). Socio-cultural norms in Arab countries, where rich high-fat food play an important role in the daily diet and where "plumpness" (fatness) is considered healthy and a sign of beauty and affluence, have been suggested as underlying factors in the alarmingly high prevalence of obesity in the region (Nasser, 1986; Al Shammari *et al.*, 1994b; Al-Isa, 1997). Several studies (Amine and Samy, 1996; Al-Isa, 1997; Al-Isa and Moussa, 1998; Al-Mahroos & Al-Roomi, 1999; Hassan and Al-Kharusy, 2000; El-Hazmi and Warsy, 2002; Jeya *et al.*, 2004) described that Arabian Peninsula (or Arabian Gulf Region) countries have undergone significant epidemiological transformation over the past two or three decades resulting in the modification of lifestyle to a more sedentary way of living, with considerable reduction in the extent of physical activity, and increase in intake of fast foods.

1.7.1 Kuwait and Arabian Peninsula countries

The prevalence of adult obesity and type 2 diabetes in Kuwait is among the highest in the Arab peninsula (Abdella *et al.*, 1996), and cardiovascular disease, for which obesity is a risk factor, is the leading cause of mortality and morbidity (Moussa *et al.*, 1999). The rise in the prevalence of obesity does not start suddenly, as it is likely to be emphasised during childhood. Al-Isa and Moussa (1998), who studied obesity among Kuwaiti pre-school children, aged 0 – 5 years, found 7.5% of male and 9.0% of female children were obese. The proportion increased to 8.1% and 8.8% for school children aged 6 – 9 years, and to 36.8% and 35.9% for those aged 10 – 13 years (Al-Mousa and Parkash, 2000).

Several studies suggested that childhood obesity in Kuwait is influenced by social and environmental factors (Eid *et al.*, 1986; Moussa *et al.*, 1999; Moussa, 2004). Al-Isa (2005) has shown that when compared to the NCHS reference population, the BMI of Kuwaiti adolescents aged 10 – 14 years exceeded that of their American counterparts in each centile categories > 50th centile. Their BMI also exceeded those of the Saudis. Among males, overweight and obesity was found to be 29.9 and 15.7%, respectively. In females, overweight and obesity were found to be 31.9 and 13.1%, respectively. This highlights the fact that there is a grave need in the region for researches based on comparison with previous local subjects, to help in better understanding the trend of obesity problem. Currently, it is believed that the economical status is an important drive that contributes to the rapid progress in Kuwait and brings to light new dietary and activity habits.

Nevertheless, effort is still required to prove that the present population is more overweight than those lived previously in less comfortable lifestyle. In view of the fact that genetics of various populations is not expected to change in the past 100 years (Das, 2005), the comparison of physical characteristics (weight, height, and BMI values) of current subjects with those lived few decades ago is required to prove the impact of the environmental factors that associated with the socio-economic transition.

In other Arabian Peninsula countries such as Saudi Arabia there is a problem of being overweight and obese in addition to incorrect balance between body fat and muscle content resulting in over-fatness and under-muscularity among Saudi adolescents (Abalkhail and Shawky, 2002). A plausible hypothesis is that modernisation has affected both Saudi boys and girls. In Saudi Arabia, one in every six children aged 6 to 18 years old is obese (Al-Nuaim *et al.* 1996a; and Al-Nuaim *et al.* 1996b). El-Hazmi and Warsy (1997) attributed the high prevalence of obesity in the Saudi population to several factors. According to them the factors include 1) Dietary habits: There is a high consumption of dates and carbohydrate-rich food. 2) Lifestyle: The lifestyle is quite sedentary, especially for females, and most of the time is spent indoors. Only a very small proportion of the population is active. The majority of the households have help maids and socializing is frequent. 3) Climate: The climate is generally hot for at least six to eight months of the year in most regions. The hot climate does not encourage individuals to indulge in many physical activities and cars are used for even short-distance travel. Afternoon siesta, soon after a meal, is an ingrained habit and can be considered as a factor in the aetiology of obesity. Abalkhail (2002) attributed the changes in overweight and obesity in both sexes to the increase in body weight rather than changes in height since there were no apparent changes in height over time.

Among Bahrainis, Al-Mahroos and Al-Roomi (2001) found the overall rate for obesity was 29%. The association of obesity with lack of physical activity, higher levels of education, and higher income levels indicates that lifestyle factors play an important role in the aetiology of obesity among the Bahraini population.

In the United Arab Emirates (UAE) Amine and Samy (1996) reported that food intake between meals and in particular fast foods, limited physical exercise and long afternoon napping were important contributors to the development of obesity. Jeya *et al.* (2004) found that in UAE, an arid and dry region with two distinct seasons: a hot summer, with temperatures exceeding 50^{0}C, and a milder winter, for adolescent females sleeping was the predominant ''activity'' during schooldays and on the weekend between 13:00–16:30. Weather restrictions, cultural, and social change of the community play a major role in the patterns of physical activity and levels of inactivity in adolescent females in the UAE and may explain, in part, the rise in the incidence of obesity in this population. Following their study of the prevalence of obesity among school children in the United Arab Emirates, Al-Haddad *et al.* (2000) reported that the 50th centile of the BMI was not different from that for the US. Using the 85th percentile as the criterion, Al-Haddad *et al.* (2000) classified 16.5% and 16.9% of males and females, respectively, as overweight and concluded this indicates high levels of obesity were prevalent among the UAE children and adolescents. Comparing of BMIs to international reference data Al-Haddad *et al.* (2005) revealed that UAE children were at increased risk for overweight (>25 kg/m^2) and obesity (=30 kg/m^2). The frequency of obesity among UAE youth was two to three times greater than the recently published international standard.

1.7.2 Other Middle East populations

In a survey of 2 – 5 years old children in the Gilan and Sistan provinces of Iran, Dorosty *et al.* (2002) found that 8% of children were obese, which was significantly higher than expected. In Tehran (Iran Capital), Azizi (2001) found that 13.3% of girls aged 10 – 19 years and 12.6% of boys in the same age group were overweight, and 4.1% and 6.7% were obese, respectively, showing a relatively high prevalence.

According to Sibai *et al.* (2003a) most Lebanese adults, 20 years of age and older, are overweight (53%, BMI $\geq$ 25 kg/m^2), and 17% are obese (BMI $\geq$ 30 kg/m^2). The respective estimates for overweight and obese children ($\leq$ 19 years) were also high, reaching 22.5% and 7.5% in boys and 16.1% and 3.2% in girls. Whereas lack of exercise associated significantly with obesity among children, obesity in older adults was more prevalent among the least educated, and those reporting family history of obesity. Among children, boys and those who did not exercise were significantly more likely to be obese than their counterparts. In Lebanon, only a small number of schools include physical education in their curricula, and parks, public beaches, and walking/bicycle lanes are totally lacking, with the result that leisure-time physical activity remains inaccessible to a vast segment of the population (Sibai *et al.*, 2003a; Sibai *et al.*, 2003b).

In a study on overweight and obesity among School children in Sana'a City, Yemen, Raja'a *et al.* (2005) reported that the overall prevalence of overweight and obesity is 8.1% in both males and females. Females were found to have a higher BMI than males, as a majority of female students in Yemen live at home, are less active as traditional culture restricts their activity outdoors, and consequently by being more at home they are in frequent contact with food. The prevalence of overweight and obesity was also higher among non-active students when one or both of the parents are obese. The prevalence of overweight and obesity was positively associated with the father's education, as the level of education in Yemen is associated with increased income, resulting changes of dietary habit and lifestyle. Raja'a *et al.* (2005) also reported the prevalence of overweight and obesity was positively associated with students who took unhealthy food (butter, ghee, fast foods and high-energy foods).

Koçoglu *et al.* (2003) found that prevalence of obesity among Turkish children was significantly higher in habitually rapid eating children (14.8%) and in those who habitually swallow large pieces (14.6%). They found obesity was more prevalent in children who belong to high-income families and whose fathers had higher education.

1.8 Summary

Obesity has become a common medical disease in most developed and developing nations, and can result in serious co-morbidities and health consequences. While adult obesity is an important risk factor for developing type II diabetes and other non-communicable diseases (NCDs), childhood obesity is most important because adverse effects and associated risk tend to be emphasised in the early stage of life.

Socio-economic environment characterised by sedentary lifestyle and ready access to abundant food is probably the primary reason lying behind the increase in the prevalence of obesity. In Kuwait and Arabian Peninsula countries alike, the risk of obesity increased over the last few decades in tune with the socio-economic transition. The rise in the level of socio-economic status has led to changes in various lifestyle habits, such as poor food selection and sedentary lifestyle. These changes were then realised as grounds for the rise in the prevalence of obesity, see Figure 1.1.

Socio-economic transition

↓

High level of socio-economic status

↓

A significant change in the prevalence of various lifestyle habits (i.e. poor food choice and sedentary lifestyle)

↓

Energy intake exceeds energy expenditure

↓

Overweight and/or Obesity

Figure 1.1 Schematic summary of obesity development over the last few decades in Kuwait and similar Arabian Peninsula countries.

It is clear that there is a lack in the number of studies that reveal the impact of socio-economic transition in Kuwait. Except for BMI, a very few studies identified overweight and obesity based on other anthropometric techniques such SFT and WHR in Kuwait to elucidate possible evidences that the environmental risk factors are the main contributors of childhood obesity. There is also a lack of data related to the estimation of dietary intake which is usually used in combination with physical activity measurement, to estimate energy balance (energy intake vs. energy expenditure) in the region. Furthermore, available data are very scarce related to biochemical indices to ensure the current nutritional status of the Kuwaiti school-age children. The current work intend to provide further insight on this issue by the analysis of common anthropometric variables (BMI, SFT, and WHR), dietary intake and physical activity level (7-days dietary and activity records), and the components of metabolic syndrome of school age children. As far as we are aware, this is the first study in Kuwait which considers such approach and outcomes in one frame to predict the possible nutritional risks that contribute in increasing calorie intake or physical inactivity for the age group 6 – 13 years.

CHAPTER 2.0 Aims and Objectives

2.1 Rationale and Justification for the Present Study

Obesity, which is a major risk factor for many non communicable diseases (NCDs), has become prevalent in both developed and developing nations (Sinha *et al.*, 2002; Maffeis *et al.*, 2003). In Kuwait, which is in economic, epidemiological and nutrition transition, obesity and associated NCDs have recently appeared as a serious public health problem. There is growing evidence of increasing secular trends in the levels of childhood obesity in Kuwait and the Arab peninsula as a whole (Musaiger, 2004; Al-Isa, 2005; Al-shammari *et al.*, 2006). Childhood obesity as a significant precursor for adult obesity has been reported by Al-Isa (1995), and Gahagan (2004). However, the high rates of obesity accompanied by upward shifts in body-fat distributions among the population cannot be attributed solely to genetic factors as argued by others (Magbool, 1994; Lobstein *et al.*, 2004; Whincup & Deanfield, 2005). Only 1% or less of childhood obesity cases is directly caused by genetic disorder (Ells *et al.*, 2005).

Over the last 3 decades, Kuwait has undergone significant modernisation resulting in changes of dietary habits and lifestyle. A number of studies have reported a concomitant rise in obesity across all age groups and in particular, high levels of overweight and obesity pre-school and school-age children (Al-Isa and Moussa, 1998 and 2000). This shift in health habits, lifestyles and food choice especially among children may have increased the risk of NCDs among the Kuwaiti population with possible significant implications for public health and government expenditure on health. This apparent increasing secular trends however need to be examined more closely not only on the context of Kuwait but in relation to its implications for the entire Arab Gulf region where reliable epidemiological data are still relatively scarce and comparability is generally poor (Moussa, 2004; Al-Haddad *et al.*, 2005).

In Kuwait, although various studies have been carried out, to date, no single study has attempted to examine these secular trends in the context of dietary related behaviour (in particular food choice), physical activity, health habits and lifestyles among school-age children as part of single framework in order to determine associated risk factors (environmental risk factors) as a basis for suggesting ways of addressing childhood obesity and health risks in the country.

The purpose of this study is to provide a cross-sectional picture of current influences on nutritional status and point prevalence of overweight and obesity among a representative sample of school-age children (age 6 – 13 years) in Kuwait. Of particular interest is examination of secular trends in the last two decades of this cohort of children and ascertaining nutritional risk factors in relation to environmental risk factors arising from the economic and demographic transition in Kuwait with rising household incomes, food-related behaviour, physical activity and other health-related lifestyle changes occurring over the last three decades.

2.2 Objectives of the Study

The present study was designed to address the following issues:

1. Ascertain the health habits and food-related behaviours that relate to nutritional status among a representative sample of 6 – 13 year old Kuwaiti school children.
2. Study food consumption patterns and physical activity levels in a stratified sub-sample of this population.
3. Undertake a comprehensive assessment of body fatness using anthropometric indicators (employing regional and international cut-offs).
4. Assess biochemical evidence of nutritional status and NCD risk (including the use of lipid profiles, blood glucose levels, and selected minerals) as a proxy measure of risk of the metabolic complications among this population sample.

It is envisaged that findings from this study will contribute to the body of knowledge on the subject of childhood obesity in Kuwait and help clarify the extent to which environmental risk factors contribute to secular trends. The deductions made from findings could also contribute to the development of nutrition and health-related guidelines for school-age children and assist in future nutrition interventions aimed at reducing childhood obesity in Kuwait.

CHAPTER 3: Subjects, Materials and Methods

3.1 Study design

The state of Kuwait is a small Arab country located in the north eastern part of the Arabian Peninsula, bordering the Persian Gulf (known locally as the Arabian Gulf), between Iraq and Saudi Arabia (Al Khawari *et al.*, 1997). It is an urbanised and lightly populated country divided into six Governorates (Provinces). Since the government of Kuwait bears all expenses of the education of Kuwaitis, the majority of children (about 94%) go to government schools. While children aged 6 – 9 years attend primary schools those who are in the age group of 10 to 13 attend intermediate schools.

This study was conducted over the period between 2001 and 2004. During the academic year 2001/2002, the total number of school-age children 6 to 13 years old was 167055 (M=83310 and F=83745) attending a total of 349 primary and intermediate schools. Among these, 42387 boys and 42944 girls were in primary schools while 40,923 boys and 40,801 girls attended intermediate schools (Ministry of Education, 2001), see Table 3.1.

Table 3.1 A summary of total number of students in 349 primary and intermediate schools in Kuwait, academic year 2001/2002

Education level	Boys	Girls	Total
Primary (6 – 9 years)	42387	42944	85331
Intermediate (10 – 13 years)	40923	40801	81724
Total	83310	83745	167055

This study was designed to enable a cross-sectional investigation of a representative sample of 14 per cent of the total number of primary and intermediate schools in Kuwait. During recruitment, sample size calculation gave a total of 1536 representing 6.7% of 6 – 13 year olds in the 48 schools i.e. just under 1% (0.92% of total school age population) of the total number of children in this age group throughout the country.

3.1.1 Subjects

A sample population of 1536 school children (M=768 and F=768) aged 6 to 13 years, were recruited using a multistage (cluster) stratified random sampling technique

(Waterlow *et al.*, 1977; Hicks, 1982). A list of government schools was obtained from the Department of Public Relations at the Education Ministry. Two primary and two intermediate schools for each gender were randomly selected from each of the six governorates of Kuwait for drawing the sample amounting to a total of 48 schools. Students in the age group of 6 – 13 were classified into four groups, each representing one of the possible combinations of the following categories. Education: primary (6 – 9 years of age) and intermediate (10 – 13 years of age); Sex: boys and girls. A uniform sample of 96 students in each age/sex category was selected by simple random sampling proportional to the number of children in each school, using school records, with a total of 384 students in each education level/sex group; see flow chart in Figure 3.1.

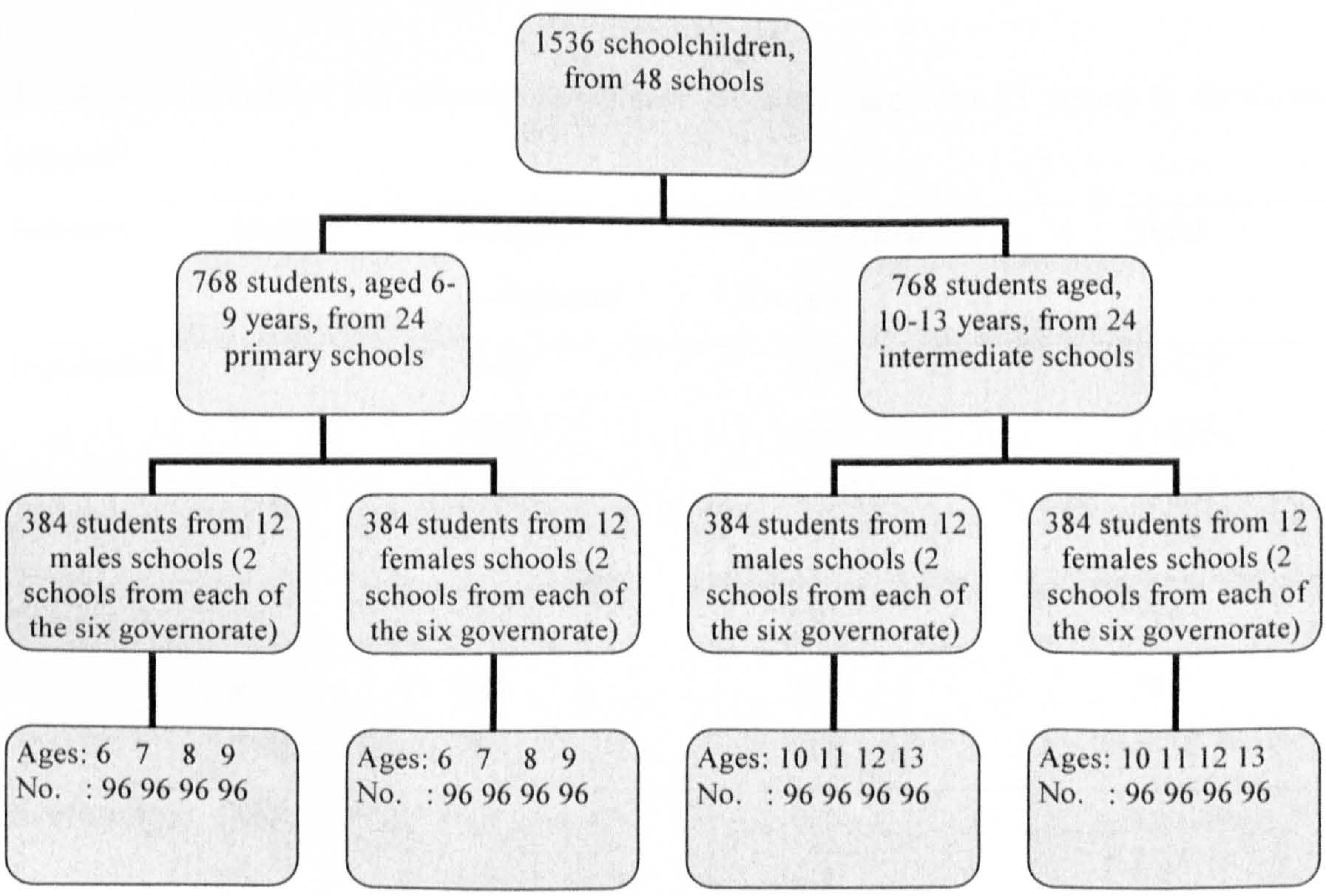


Figure 3.1 Shows a summary of the sampling techniques employed for the selection of 6 – 13 old Kuwaiti school children for inclusion in this study.

The resulting multistage stratified random sample was 1536 students representing 6.7% of the total Kuwaiti students aged 6 – 13 years in the 48 schools (Table 3.2). In 2001, a sub-sample of 224 were ramdomly selected subjects (>14% of total) with a response rate of 86.6% (n=194) undertook a 7-day dietary intake and physical activity record and anthropometric measurements. In 2003, another sample of 224 eligible subjects from the original cohort (1536) was randomly recruited to undertake a number of biochemical indices of nutritional risk. Of these, 114 accepted to participate (mean age 10.3 ±2.4 yrs) i.e. a response rate 50.9%. Although the study design was planned to include all aspects of data gathering from the outset, not all measurements were carried out during the same time frame. The rationale for choosing an unmatched sub-sample for biochemical analyses was partly the result of the volume of tasks involved in data collection, measurements and logistics.

Table 3.2 Scheme of the selected sample of students (age 6 to 13 years) in 48 Kuwaiti schools

Subjects	Gender	Primary (6-9 years)	Intermediate (10-13 years)	Total
Population	M	5528	6295	11823
	F	5601	5627	11228
	Total	11129	11922	23051
Sample	M	384	384	768
	F	384	384	768
	Total	768	768	1536
% of sample	M	6.9	6.1	6.5
	F	6.8	6.8	6.8
	Average	6.9	6.4	6.7

The age of students was determined from records of their dates of birth. The age was rounded to the nearest year, e.g. 9 years and 5 months was considered as 9 years. Only healthy students were included in the study and students suffering from chronic diseases that affect growth were excluded. In all 23 students (9 boys & 14 girls) representing 1.5% of the total sample size were excluded and replaced, using the same selection criteria, until a total number of 1536 was completed. Written informed consent (Appendix 1) was obtained from parents and teachers and assent obtained from students before they were included in the study.

3.1.2 Sample size

Irrespective of the original distribution, if the sample size is big enough (typically > 30), then the sample mean will have a normal distribution. This useful approach is known as the central limit theorem (Clarke, 1993; Mason *et al.*, 2003). For a normal distribution, 95% of values lie between ±1.96 standard errors from the mean i.e. the normal distribution is symmetric around the mean.

In this study, the sample size was determined to ensure there were 384 students in each education level/sex group as it was believed to be adequate for achieving precise estimates of prevalence, with 5% error in the sample estimated at the 95% confidence levels. The below formula was used to ensure the adequate sample size based on figures from a previous study on children in Kuwait, where several studies reported that the prevalence of total overweight (overweight and obesity) among Kuwaitis was 40 to 50% (Al-Isa and Moussa, 1998; Moussa *et al.*, 1999);

$n = t^2 \times P\,(1 - P) / d^2$ (Hicks, 1982; Mickey *et al.*, 2004)

Where n = sample size; t = level of probability that the prevalence is within the chosen value (is a number taken from the distribution tables) of d required; d = the level of precision (sampling error) required for results; and P = the estimate of the current population prevalence of overweight and obesity in school-age children in the population under consideration (any value ≥ 40 to ≤ 50% can be used, or using the probability of 50% if no local prevalence values available).

The compensation of such formula is:

The sample size for each group = $(1.96)^2 \times 0.5\ (1 - 0.5) / (0.05)^2 = 384$ subjects
As the population of students in this study was divided into 4 groups,
Therefore, total sample size (n) = 384 × 4 = 1536 subjects, which is the original sample

To ascertain dietary intake, physical activity, and anthropometric measurements, a sub-sample was determined. In fact, researchers and statisticians accept the power of confident from 80% and 10% for sampling error (Mickey *et al.*, 2004, Al Mousa *et al.*, 2003). In this study the adequate individuals in sub-sample were tested to ensure not more than 10% error in the sample estimated at the 95% confidence level.

By compensation on the above equation:
Therefore, $n = (1.96)^2 \times 0.5\ (1 - 0.5) / (0.1)^2 = 96$ subjects, at least in each gender. Since, large sample size is giving more accuracy, 112 students were chosen for each gender, with a total of 224 students.

3.2 Data collection

3.2.1 The design and pre-testing of a socio-demographic and Nutritional status-related habits questionnaire

The questionnaire (instrument) employed in this study was designed to obtain socio-demographic information and to assess the importance to individuals of a range of factors related to health and nutritional status (Steptoe *et al.*, 1995). It was used to elicit information on factors that relate to intakes of foods, health habits, and influences on children behaviour. All the selected subjects (n = 1536) were asked to answer the questionnaire. The data was collected through structured interviews of parents and/or subjects. The questionnaire had 29 questions enquiring about the background, habits and eating behaviour of subjects. The questions were grouped into four categories. Section one dealt with personal information (e.g. number of siblings, educational levels of parents, and net monthly family income); section two included questions on physical activity and leisure interests. Section three focused on information on general health habits and behaviours; whilst section four had specific questions on food habits.

This is a modified questionnaire has been validated and reliability checked based on Pollard *et al.* (1998) incorporating a modified health habits and food frequency questionnaire based on the Third National Health and Nutrition Examination Surveys (NHANES III, USDA) format. This was tailored to meet local needs, and pitched at a level of understanding of the children and their parents and also translated appropriately in order not to lose any meanings. Sensitivity to culture and selection of appropriate words were also considered. Recently, in order to combat public health consequences most of the questionnaire questions of this study were administered in schools as part of the class-room activity to provide a standard administration (e.g. a study of self-reported dental pain and associated factors in Ugandan school children (Kiwanuka & Astrøm, 2005). Another study introduced evidence on the reliability and validity of the health behaviour in school-aged children using some similar questions of our current questionnaire (Vereecken & Maes, 2003). However, there is a possibility that some questions did not reflect the current lifestyle and habits of some subjects although we have no evidence this was the case because prior to the data collection the variables (questions) of survey questionnaire were pre-tested among comparable groups of children (80 randomly selected students; > 5% of total sample) in order to assess reliability and validity from different schools, and to assure a better understanding of related questions to the surveyed subjects of this study. Surveyed subjects were also fully instructed about the nature of the questionnaire and prior to acceptance, the parents or guardians of the children were fully informed about the objectives and they gave their informed consent (Appendix 1). Furthermore, prior to answer the questionnaire, parents/guardians and teachers were informed to assist recruited subjects (especially for those in primary schools 6 – 9 years of age) to understand the meaning of questions (first page of Appendix 2).

3.2.2 Dietary intake and physical activity assessments

The estimation of dietary intake is usually used in conjunction with physical activity measurement to determine the balance between energy intake and energy expenditure. Two surveys are generally performed by researchers to collect data, either during 24-hour dietary and physical activity recalls, or by 1-7-day dietary (food) and physical activity records (Sempos *et al.*, 1992; Macdiarmid & Blundell, 1997; Smithers *et al.*, 2000). While the 24 hour recall method was used by few studies, the dietary record intake (7-days), as far as we are aware, has never been used to elucidate the most frequent pattern of diet and calorie intake in Kuwait and probably in the Arabian Peninsula region for the age group 6 – 13 years. Similarly, there is a lack of data related to the 7-day physical activity records in the region.

Although, actual measurements of the various components of energy balance are difficult to undertake, the assessment of total daily dietary intakes using the food record method has provided a sound basis for the estimation of daily energy intakes from previous studies despite its potential drawbacks, especially in assessing young children (Sempos *et al.*, 1992; Buzzard, 1994; Schroder *et al.*, 2001). Furthermore, prediction equations for the estimation of total daily energy expenditure which take into account BMR and physical activity levels (PAL) in relation to age and gender have given reliable data in studies of energy balance in different age groups (Schofield *et al.*, 1985; and WHO, 1985; Baur *et al.*, 2000; Steinbeck, 2001; Department of health, 2003).

In nutritional assessment, dietary methods require to accomplish surveys measuring quantity of nutrients intake or food consumption during a specific interval to understand a range of related standards. In order to collect data, the two surveys (during 24-hour dietary recall or 1 to 7-day dietary records) are performed by using food composition tables or specific computer programs to convert dietary intake data to nutrient intake data or food contents. In spite of the limitation of these tables (e.g. the potential error of computerised diet analysis programs), these data have considerable value in assessing nutritional status when applied in conjunction with anthropometric and biochemical data (Beaton, 1994).

A person's food selections and physical activity change from day to day, and therefore a single 24-hour recall is not representative of a person's usual diet and activity (Witschi, 1990, Conway *et al.*, 2002). This study has tried to obtain information on nutrient intake and physical activity ratio by using 7-days dietary and physical activity record methods on a sub-sample of study population. Although, both dietary and activity records for seven days need much effort and long time, findings of these methods are clearly advantageous to have valuable information help to introduce evidence that the types and excessive intake of nutrients in addition to increased physical inactivity are the main reason of obesity. The main advantages to using this method, it provides a large amount of interesting physiological and social information on life styles, as well as it provides information about the types and strenuousness of different forms of physical activity (Torun, 1996; MacIntyre *et al.*, 2004). Furthermore, detailed outcomes can help Kuwaiti authorities make a correct decision in this regard for future interventions or governmental programmes.

3.2.2.1 Dietary intake

Dietary intake data were collected via a 7-day food record diary form (Appendix 3). A sample of 194 subjects (M=99 and F=95) completed these food records with parental guidance. Subjects were asked to keep a record of everything they ate and drank, including the type of food, food preparation methods and the amount eaten, as suggested by Willett, (1998). They were also expected to include food and drink and snacks eaten outside the home (e.g. school meals). Furthermore, written instructions and directions for using the food diary were provided to assist in completion of the diary (Appendix 3). Data collected from all 7 days' food records were collated into an excel spreadsheet and used to estimate the intake of energy, macronutrients, and micronutrients.

For each individual, the averaged values obtained from 7 days intake were calculated and reported as average daily intake of energy and other nutrients using regional and international food composition databases (Sawaya *et al.*, 1998; Lee & Nieman, 2003) including the USDA food database. The database of Sawaya *et al.*, (1998) was employed with particular reference to recipes and dishes that were specific to Kuwait and the Arab Gulf region. For other foods for which local dietary reference values were not available, energy and nutrient intake data were estimated using the international food databases. Comparisons of intake were then made with UK dietary reference values (DRVs), (Department of Health, 2003). Energy intake (EI) was compared with the estimated average requirements (EAR) in kcal/d (more recently, WHO and FAO have recommended the use of mJ/d as a preferred way of reporting energy intakes). Nutrient intakes were compared with reference nutrient intakes (RNI) for three age groups 6, 7-10, and 11-13 years.

3.2.2.2 Physical activity

Physical activity is a flexible component of the energy expenditure equation, and is measured as a part of the nutritional status assessment of individuals (Steinbeck, 2001). Physical activity of the 194 subjects was assessed by the diary method using a validated physical activity questionnaire for children and adolescents (Lee & Nieman 2003; Department of health, 2003) which was adopted and modified to suit the context of this study. Parents were asked to assist in the accurate reporting of the type and duration of physical activity (Mamalakis *et al.*, 2001) undertaken by the subjects over a seven-day period. For each individual, the averaged values obtained from 7 days physical activity diary were calculated using physical activity ratios for specific activities (Schofield *et al*, 1985) to quantify the qualitative data obtained of physical activity. These values were then transformed (as shown in the equations below) into daily physical activity levels (PAL) and reported as such.

The steps involved in estimating PAL are summarised as follows:

A. Estimation of basal metabolic rate (BMR). Equations for estimating BMR for individuals of both genders using age and body weight were derived from Schofield *et al.* (1985) study, as following:

Males: $BMR = (17.7 \times \text{body weight}) + 657$ (Kcal/day)

Females: $BMR = (13.4 \times \text{body weight}) + 692$ (Kcal/day)

B. Estimation of PAR: Physical activity ratio (PAR) was used to provide an energy cost for each activity. The energy expended by subjects aged 6 – 13 years in physical activity terms was calculated from the typical time used for various specific activities and the energy cost of each activity (e.g. see Table 3.3 and Appendix 4; Department of Health, 1991; 2003).

C. Estimation of total daily energy expenditure (TEE). Published values of energy costs were employed in transforming individual data from BMR and PAR into TEE values (Torun, 1990; Torun *et al.*, 1996; Ainsworth *et al.*, 1993; Ainsworth *et al.*, 2000; Harrell *et al.*, 2005). The energy costs of activities performed over half to one hour as PAR are given in Appendix 4 (derived from the Committee on Medical Aspects of Food Policy (COMA) (Department of Health, 2003).

D. Estimation of Physical Activity Levels (PAL). Physical activity level (PAL) was calculated by the ratio of total daily energy expenditure (TEE) to basal metabolic rate (BMR), according to the following formula suggested by James & Schofield (1990), Black (2000) and Conway *et al.*, (2002):

$$PAL = TEE / BMR$$

E. Following estimation of daily energy intake and expenditure using the various prediction equations above, the average ratio of energy intake to basal metabolic rate (EI / BMR) were also calculated for all subjects included in this part of the study. Comparisons of intake were then made with expenditure.

Table 3.3 Duration of time spent and energy cost of activities (PAR)

Activity	Hours	Energy cost (PAR)	
		Boys	Girls
Bed	8	1.0	1.0
School	6	1.6	1.5
Light	7	1.6	1.5
Moderate	2.5	2.5	2.2
High	0.5	5.0	5.0
Average	4.8	2.34	2.24
PAL	24	1.56	1.48

Source: the Committee on Medical Aspects of Food Policy (COMA) (Department of Health, 2003).

The method which has been used (timed record of activities and associated energy costs) consists of a combination of a timed activity record, i.e. the average total duration of each of the activities throughout the whole 24h of the day (for 7 days), and an energy value (in kcal/min) for each of these activities. These energy values were derived from published data. In fact, physical activity records have the unique advantage of providing additional information on the types of activity and time devoted by individuals to specific activities (Conway *et al.*, 2002).

Note: Almost every occupation needs some mix of light, moderate, or vigorous activities, depending on the task performed. To categorise the activity level of any position the following steps were performed:

1. How many minutes (or hours) each day did the subject spend on the types of activities expressed as light, moderate, or vigorous?
2. To achieve a total caloric expenditure, minutes spent doing activities within each intensity level were multiplied by the kilocalories corresponding to each level of intensity.

Then, the total kilocalories spent doing light, moderate, and vigorous activities were added together to arrive at the subject's total energy expenditure in a typical day.

3.2.3 Anthropometric measurements

Quantification of adipose tissue mass can be achieved by a number of laboratory methods including underwater body density measurement and body fat content estimated by the dual energy X-ray absorptiometer (DEXA). Magnetic resonance imaging (MRI) and computed tomography (CT) have provided researchers with opportunities to describe human adiposity in further detail (Lukaski, 1987; Seidell *et al.*, 1987; Gray *et al.*, 1991; and Sobol *et al.*, 1991).

Although, accurate measures of body composition often are required as scaling factors to normalize physiologic variables (Goran, 1998), measuring body fat by these techniques is often expensive and not readily available. For individual assessment of body composition, anthropometry is being replaced by more accurate but also more complicated methods. It however remains a valid tool for epidemiological studies of the body composition in large groups (Abalkhail & Shawky, 2002; Lawlor & Leon, 2005). In large-scale population surveys, several studies highlighted that body mass index (BMI), waist to hip circumferences ratio (WHR), and skinfold thickness (SFT) are commonly used, in spite of variations and limitations, as a surrogate to indicate the extent of overweight and for body fat content (Krotkiewski *et al.*, 1983; Flood *et al.*, 2000; Dehghan *et al.*, 2005).

In order to determine the impact of energy intake and physical activity levels on body composition, a number of physical measurements were performed on each of the 194 subjects (M=99; F=95) who undertook a 7-day food record and activity diary. Weight and height were measured from which the body mass index (BMI) was subsequently calculated. Body girth measurements (Waist and Hip Circumference) and skinfold thickness (SFT) were also measured at selected sites for children (Lohman, 1987; Lukaski, 1987; Lohman *et al.*, 1991; WHO, 1995).

3.2.3.1 Weight, Height, and Body Mass Index

Weight and height can be compared to reference data and reported as Z-scores (or standard deviation (SD) score), percentiles, or percent of median (Wang *et al.*, 2002). Z-score is useful because a population can be expressed statistically, and then z-scores can be used as cut-points (Armitage & Berry, 1987; Flood *et al.*, 2000). However, the most widely surrogate index used is Quetelet's index, better known as body mass index (BMI). It has been used routinely to classify subjects as obese or non-obese (Dalton *et al.*, 2003). The BMI-based classification of overweight and obesity has been well received by the research community (Seidell *et al.*, 2001), making comparisons for obesity prevalence between or within populations feasible.

The common categories used for classifying individuals and populations as overweight and obese was defined by WHO, overweight as BMI of 25 or more and obesity of 30 or more (WHO, 1998). The cut-off point for obesity merely indicates the greatly increased health risks above this level of body fatness (30 kg/m^2). However, the main disadvantages to using BMI indicator, it does not distinguish between weight due to muscle and that due to fat although the correlation between BMI and body fat adjusted for height is high (Harrison, 1985; Spiegelman *et al.*, 1992; Pietrobelli *et al.*, 1998). Furthermore, these cut-off points do not apply well for children because BMI changes throughout childhood (Obarzanek, 1993; Dietz & Robinson, 1998). As an alternative, Center for Disease Control and Prevention (CDC) in United States has developed paediatric growth charts to be used for assessing the nutritional status of children and teens 2 – 20 years of age, for both genders males and females. The charts illustrate percentile curves (cut-off points) of height for age, weight for age, weight for height, and BMI for age available from the website of the National Center for Health Statistics at www.cdc.gov/growthcharts (Kuczmarski *et al.*, 2000). Gahagan (2004) reported that the percentile cut-off points were established to identify underweight, overweight, and obesity in children as following:

Underweight BMI-for-age < 5th percentile
Overweight BMI-for-age ≥ 85th percentile to < 95th percentile
Obesity BMI-for-age ≥ 95th percentile.

Weight was measured with subjects bare footed and wearing light clothing (school physical education uniform e.g. very light shorts and vest for boys) to the nearest 0.1 kilogram (kg) employing a pre-calibrated electronic digital SECA weighing balance with an attached stadiometer (SECA 770, UK). Each measurement was taken at the same time in the morning before subjects had their breakfast. Three measurements were taken of the weight in each individual and the average of two concordant readings used as the weight of the subject.

Height was measured to the nearest 0.1 centimetre (cm) using an attached stadiometer. Each subject instructed to stand barefoot in the Frankfurt horizontal plane (looking straight ahead). Three measurements were taken for each subject and each measurement of height recorded was the average of two concordant readings.

Body-Mass Index (BMI), i.e. the measurement of weight relative to the square of the height in metres (m^2), for children (Cole *et al.*, 2000) was calculated using the following formula:

$$BMI = Weight (Kg) / Height (m^2)$$

BMI is a simple measure of body size and has been widely used to define overweight and obesity first in adults and now more generally accepted in children (Magbool, 1994; Colditz *et al.*, 1995; Cole *et al.*, 2000; Kuczmarski *et al.*, 2000). Further analysis was carried out using BMI-percentile charts for boys and girls. BMI were compared to reference data and reported as Z-scores, and percentiles (Armitage & Berry, 1987; Al-Isa & Moussa, 2000). Z-score = (Observed value) - (Median value of the reference population) / (Standard deviation (SD) value of reference population). However, Goh *et al.* (2004) concluded for more effective management of the problem of obesity, more precise, simple, and cost-effective methods for the measurement of body fat percentage (%BF) should be developed. In order to overcome or decrease the limitations of any indicator used, a combination of BMI with other anthropometric variables, such as WHR and SFT are considered by present study. The results with possible variations of the three measurements are gathered and taken into account.

3.2.3.2 Measurement of body fat composition

Although, SFT technique has been used extensively (Hartz *et al.*, 1983; Dehghan *et al.*, 2005), there are other methods available to measure the percentage of body fat including underwater weighing (hydro-densitometry) and magnetic resonance imaging (MRI). The most valid and reliable estimates of visceral fat can be obtained by using imaging techniques such as computerized tomography (CT) and magnetic resonance imaging (MRI) (van der Kooy and Seidell, 1993). These techniques are able to differentiate between subcutaneous and visceral abdominal fat (Ashwell *et al.*, 1985; Sobol *et al.*, 1991). However, these methods are laborious and expensive. In addition, involvement of radiation exposure with CT limits the frequency of measurements (Jebb and Elia, 1993; van der Kooy and Seidell, 1993). Accordingly, these techniques are not suitable for screening large groups of individuals (Molarius and Seidell, 1998; Rankinen *et al.*, 1999).

At present, there are excellent anthropometric equations that use either SFT or circumferences and diameters to estimate body composition (total body density and body fat) for large groups at relatively low cost. However, the accuracy of these tests is affected by the level of technician experience and how he/she use the related equipment. Trained individual to carry out these tests is important to minimise measurement error, otherwise leads to an inaccurate estimate of the subjects' body composition.

For large population-based studies and clinical situations, bioelectrical impedance analysis (BIA) is also suitable to be used. Cross-sectional studies have shown that BIA predicts total body water (TBW), fat-free mass (FFM), and fat mass or percentage of body fat (%BF) among children (Deurenberg *et al.*, 1989; Deurenberg *et al.* 1990a; Deurenberg *et al.*, 1990b; Danford *et al.*, 1996). Phillips *et al.* (2003) reported that BIA provides accurate estimation of changes on %BF and fat free mass (FFM) over time. Furthermore, BIA does not require much training and practice to be performed but it is more expensive than SFT method. The main limitation to using BIA is that the surveyed subjects must adhere to strict pre-test guidelines in order to yield valid estimates of their body composition, which is mainly not acceptable by children.

In current study, body fat composition was assessed using skinfold thickness (SFT). The rationale was based on the fact that skinfold thickness can be used for large population-based studies to estimate regional fat distribution by determining the ratio of subcutaneous fat on the trunk and extremities and to establish reliable anthropometric profiles (Lukaski, 1987) and is an index of central adiposity in children (WHO, 1995; Nassis *et al.*, 2005). This 2-component measurement of subcutaneous adiposity has been employed in many studies to estimate total body fatness in large-scale epidemiological surveys involving children including the National Health and Nutrition Examination Surveys [NHANES III] (Frisancho, 1990; Heyward & Stolarczyk, 1996; Potvin *et al.*, 1999; NCSH/CDC, 2000). Furthermore, the relative predictive accuracy of the BIA method is similar to the SFT method (Heyward & Stolarczyk, 1996). Flegal *et al.* (1990) study suggested that skinfolds more closely reflect the amount of adipose tissue but are subject to large measurement errors.

In order to decrease measurement error as possible, skinfold thickness was measured by present study at only 2 different sites (triceps and subscapular skin fold) on the body to estimates %BF in boys and girls. These two sites were recommended by Lohman (1987) to assessing body composition for young people age 6 to 20 years, with cut-points of 25% fat in girls and 20% fat in boys. These sites have many advantages including that they are highly correlated with other measures of body fatness, they are more reliably and objectively measured than most other sites, and reference measures are available for them (Lee & Nieman, 2003).

Skinfold thickness was measured at two different sites on the body to the nearest 0.5 millimeter (mm) using a pair of Slim Guide plastic clippers calibrated against Harpenden skinfold calliper. All measurements were taken on the left side of the body. The left triceps and subscapular skinfold thicknesses were measured, ensuring that the subject was standing with the upper extremities rested at the sides of the body (Mamalakis *et al.*, 2001). The site measured was identified and marked after initially using a flexible anthropometric tape to locate the mid upper arm as a landmark (midpoints on the body).

Measurement involved first picking up a fold of skin at the site using the thumb and index finger, then gently placing the pair of callipers approximately 2.5 cm below the site where the skinfold was held (Figure 3.2; Lee & Nieman, 2003). The callipers were gently released and allowed to give stable readings for up to 3 seconds and the value recorded. This process was repeated three times and the average value of two concordant readings recorded as the skinfold measurement. Similarly, the sub-scapular skinfold measurement was taken at a landmark identified at the angle of the scapular and a similar procedure followed in order to record the measurement.

Figure 3.2 Illustration of how to measure the thickness of a fold of skin with its underlying layer of fat to estimate the % body fat, by a Slim Guide plastic.
Source: www.bodytrends.com

3.2.3.3 Waist circumference to Hip circumference Ratio (WHR)

It has become increasingly clear that not only the amount of fat deposited on the body but where it is situated is responsible for the increased risk for diseases (Hartz *et al.*, 1983; Lapidus *et al.*, 1984; Larsson *et al.*, 1984; Carey *et al.*, 1997; Folsom *et al.*, 1998; Megnien *et al.*, 1999). The importance of fat distribution was recognised in the middle of the last century, when subjects with an android body type (upper body fat accumulation) were shown to have a higher probability of various diseases than gynoid-type subjects (lower body fat accumulation) (Vague, 1956).

A variety of other anthropometric indicators have been suggested as optimal predictors of visceral fat. The most commonly used indicator is the waist-to-hip ratio (WHR), which was initially proposed in Sweden (Krotkiewski *et al.*, 1983) and in the United States (Hartz *et al.*, 1983) in the early Eighties. Waist-to-hip ratio (WHR) combines two circumference measurements: the waist measurement includes visceral organs and abdominal fat, whereas that of the hip reflects fat mass as well as muscle mass and skeletal frame (Molarius & Seidell, 1998). Waist and hip circumferences are relatively uncomplicated and quick technique employed to indicate abdominal obesity using simple equipment and has been shown to be a good predictor of visceral fat by several studies (Kahn *et al.*, 1996; Yamaguchi *et al.*, 1996; Paccaud *et al.*, 2000; Dalton *et al.*, 2003).

Although WHR is a powerful predictor of numerous diseases (Björntorp, 1993; Allison *et al.*, 1995; Seidell *et al.*, 1997), WHR as a ratio is not easy to interpret biologically or to use in statistical analyses. The most important limitation in using this anthropometric indicator for assessing abdominal obesity is the lack of universal threshold values or cut-off points (Seidell *et al.*, 2001). Attempts have been made by scientists to derive cut-off points for WHR but no consensus has been reached about the appropriateness of these different cut-off points (Molarius and Seidell, 1998). However, several studies found WHR is useful in public health work and continues to be a useful research tool in epidemiological studies (Björntorp, 1993; Lissner *et al.*, 1998; Klein *et al.*, 2004).

In the present study Waist and hip circumferences were measured using flexible anthropometric tapes (Body Care, UK) measuring to the nearest 0.1 cm (Flood *et al.*, 2000). Waist circumference was measured at a level midway between the lowest margin of the last rib (or the level of the xiphisternum in front) and the iliac crest (or level of the umbilicus) in a horizontal plane. Hip circumference was measured at the maximum widest point over the buttock (i.e. using the left and right greater trocanter of the femur as landmarks).

For each of waist and hip circumference, three measurements were recorded and two concordant readings for each measurement were recorded for each subject. The waist-to-hip ratio (WHR) was then calculated by dividing the mean waist circumference by the mean hip circumference.

3.2.4 Biochemical investigations

Biochemical examinations are also an important tool to ensure the present and future health risks. The high quantity of glucose in serum is regarded as an indicator of diabetes, the level of haemoglobin in blood describe iron status, and cholesterol levels in blood can guesstimate coronary heart disease risk (Mamalakis *et al.*, 2001). Numerous studies reported that undesirable levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL-c) cholesterol, triglycerides (TG), and fasting insulin are associated with adiposity in children (Laskarzewski *et al.*, 1980; Aristimuno, 1984; Smoak *et al.*, 1987; Ronnemaa *et al.*, 1991; Wattigney, 1991; Freedman, 1999). Recently, the incidence of metabolic syndrome (syndrome X) among population has attracted much attention. However, this new concept was considered by very rare studies in the region and therefore there is a need to identify whether Kuwaiti schoolchildren are at increased risk of the metabolic syndrome.

A further sub-sample of 224 subjects was recruited from the original cohort (1536) to undertake biochemical measurements in 2003. With a 50.9% response rate, a total of 114 subjects eventually took part (M=54; F=60); average age 10.3 (±2.4) years. The sample size was determined to ensure there were at least 96 students in each sex. Subjects were fully briefed about the nature and purpose of the biochemical measurements and prior to acceptance, the parents or guardians of the children were fully informed about the objectives and methods and they gave their informed consent.

All biochemical investigations were undertaken at the specialist laboratory of Al-Razi Hospital, Kuwait city, employing the CX7 analytical (automated Biochemistry analyser) and Sysmex SF 3000 (automated Haematology Analyser) instruments, USA. While SF 3000 reagents were purchased from Sysmex Corporation, USA all others reagents used in the study were from Beckman Instruments, Inc., USA. Centrifugation was done using a MISTRAL 1000 centrifuge (MSE Company, USA).

For biochemical studies early morning venous blood samples were collected after a 12-hour overnight fast to analyse the lipid profiles, serum glucose, magnesium, calcium, and iron status. Professional staff collected the blood samples using standard scientific methods and following health and safety procedures. Sample tubes were kept closed at all times in a vertical (stopper-up position), for no longer than two hours before serum was separated by centrifugation. Samples were stored frozen at −15 to −20°C for a maximum of four weeks until all of them were analysed. All biochemical variables were determined using a Beckman Synchron CX7 instrument (Beckman, 1996), employing time end point methods (Bucolo & David, 1973; Allain *et al.*, 1974), and biosensor technology (Byfield *et al.*, 1994). Haemoglobin (Hb) analysis was carried out directly without centrifugation, using fully automated Sysmex SF – 3000 haematology analyser.

3.2.4.1 Synchron Delta CX7 System

The system was manufactured by Beckman Instruments, Inc. It is a random access clinical analyser capable of performing a wide variety of chemistry tests in a single run. All calculations are performed by the system internally, including sample preparation dilutions, to produce the final reported result. Although the analyser performs only those tests programmed by the operator, all system functions are totally automated and under control of the onboard microprocessors (Beckman, 1996).

The system contains individual sectors, with each sector capable of holding 7 samples. It is connected with a computer system in order to achieve the routine operation by programming samples, loading reagents, or performing any of the special function options that are available. Then, the concentration of physico-chemical signals originating at the electrodes in the flow cell and the sensors in the reaction cups are amplified and subsequently processed and outputted to actual concentration values.

Glucose (Glu)

One glucose reagent bottle (500 ml), Synchron CX calibrators 1, 2 & 3, two levels of control material, Synchron CX wash solution and saline were used to quantitative the analysis of glucose in serum by Synchron CX7 Delta System. Acceptable reagent performance was measured by successful calibration and by ensuring that quality control results are within our facilities acceptance criteria. The glucose assay was calibrated every 24 hours by calibrators 1, 2 & 3 and also calibrated after changing new bottle reagent or wash solution, in addition to two levels of control material, normal and abnormal, were analysed daily.

This instrument determines the concentration of glucose by an oxygen rate method using a Beckman oxygen electrode (Kadish *et al.*, 1968). Ten μL was injected into a reaction cup containing a glucose oxidase solution, where the ratio used is one part sample to 100 parts reagent. The rate of oxygen consumption was determined by electronic circuits, which was directly proportional to the concentration of glucose in the sample (Morrison, 1972).

A constant voltage was applied through an electrochemical cell and then the current flow that is produced by oxidation / reduction reactions (Figure 3.2) proportional to the concentration of the analyte which gives a linear response proportional to glucose concentration, especially in diabetic blood samples. The glucose concentration that was measured based on immobilised enzyme-glucose oxidase (GOD) used to oxidise glucose to produce hydrogen peroxide (H_2O_2). Subsequently, H_2O_2 was destroyed until not back to oxygen by adding ethanol to the reagent in the presence of catalase, and then iodide and molybdate were added to ensure complete destruction of H_2O_2. The following reactions explain the pathway:

$$\text{Glucose} + O_2 \xrightarrow[H_2O]{(GOD)} \text{Gluconic acid} + H_2O_2$$

$$H_2O_2 + O_2 \xrightarrow{\text{Catalase}} \text{Acetaldehyde} + H_2O$$

$$H_2O_2 + 2H^+ + 2I^- \xrightarrow{\text{Molybdate}} I_2 + H_2O$$

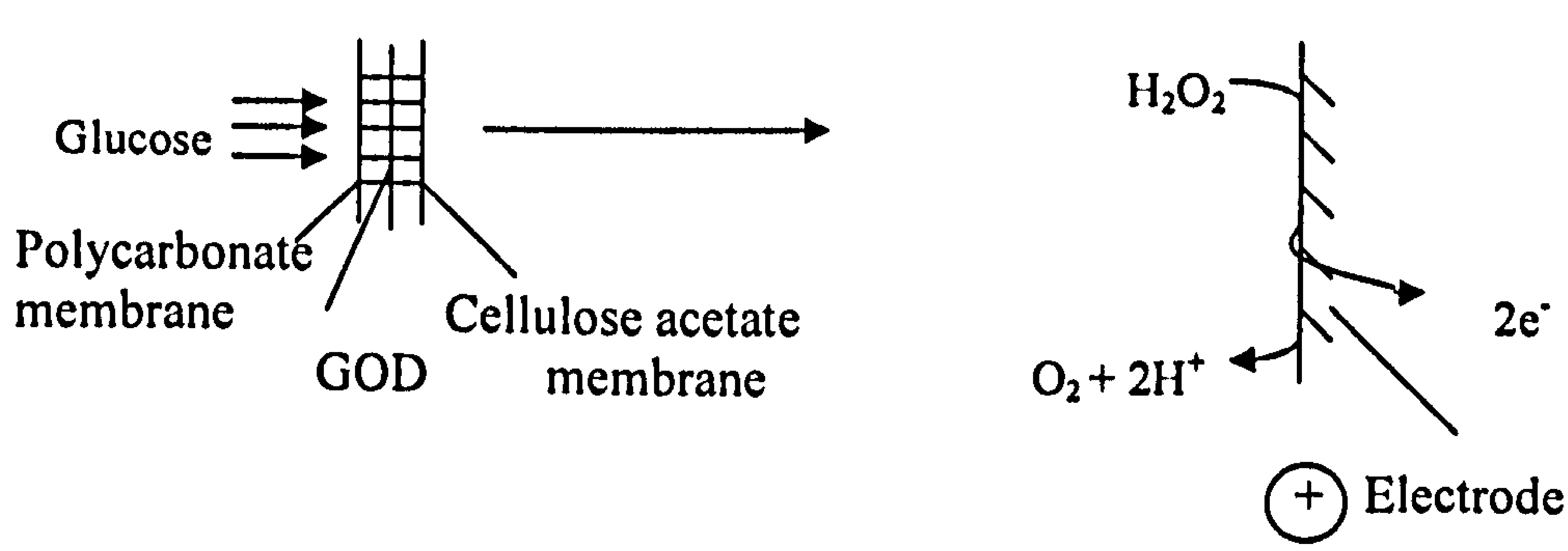


Figure 3.3 Shows the oxidation of H_2O_2 with a constant voltage.

Triglycerides (TG)

Two triglycerides reagent cartridges (2 × 300 tests), CX multi calibrator, two levels of control material and Saline were used for the quantitative determination of total triglycerides concentration in serum on Synchron CX Delta Systems. Acceptable reagent performance was measured by successful calibration and by ensuring that quality control results are within our facilities acceptance criteria. The triglycerides glycerophosphate oxidase (GPO) reagent cartridge was calibrated every 14 days and also calibrated after changing new reagent cartridge, in addition to two levels of control material, normal and abnormal, were analysed daily.

Triglycerides GPO Reagent is used to measure the triglycerides concentration by a timed endpoint method (Bucco *et al.*, 1973). Because of the action of lipase, triglycerides in the sample are hydrolysed to glycerol and free fatty acids. A sequence of three coupled enzymatic steps using glycerol kinase (GK), Glycerophosphate oxidase (GPO), and Horseradish peroxidase (HPO) causes the oxidative coupling of 3,5-dichloro-2-hydroxybenzenesulfonic acid (DHBS) with 4-aminoantipyrine to form a red quinoneimine dye, see the following chemical reaction scheme:

$$\text{Triglycerides} \xrightarrow{\text{Lipase}} \text{Glycerol} + \text{Fatty acids}$$

$$\text{Glycerol} + \text{ATP} \xrightarrow[\text{Mg}^{++}]{\text{GK}} \text{Glycerol-3-phosphate} + \text{ADP}$$

$$\text{Glycerol-3-phosphate} + O_2 \xrightarrow{\text{GPO}} \text{Dihydroxyacetone} + H_2O_2$$

$$2H_2O_2 + \text{4-Aminoantipyrine} + \text{DHBS} \xrightarrow{\text{HPO}} \text{Quinoneimine Dye} + HCl + 2H_2O$$

The Synchron CX system automatically proportions the appropriate sample and reagent volumes into the cuvette, where the ratio used is one part sample to 100 parts reagent. The system (CX7) monitors the change in absorbance at 520 nanometres. Such change in absorbance is directly proportional to the concentration of triglycerides in the sample and is used by the system (CX7 instrument) to calculate and state the triglycerides concentration.

Cholesterol (TC)

Two cholesterol reagent cartridges (2 x 300 tests), CX multi calibrator, two levels of control material and Saline were used for the quantitative determination of cholesterol concentration in serum on Synchron CX Delta Systems. Acceptable reagent performance was measured by successful calibration and by ensuring that quality control results are within our facilities acceptance criteria. The cholesterol reagent cartridge was calibrated every 14 days and also calibrated after changing new reagent cartridge, in addition to two levels of control pools, one between 175 and 200 mg/dL, and the other between 200 and 240 mg/dL, were analysed daily.

Cholesterol reagent is employed to determine the cholesterol concentration by a timed endpoint method (Allain *et al.*, 1974). In the reaction, Cholesterol esterase (CE) hydrolyses cholesterol esters to free cholesterol and fatty acids. Free cholesterol is oxidised to cholestene-3-one and hydrogen peroxide by cholesterol oxidase (CO). Peroxidase catalyses the reaction of hydrogen peroxide with 4-aminoantipyrine (4-AAP) and phenol to produce a colored quinoneimine product according to the following chemical reaction scheme:

$$\text{Cholesterol ester} \xrightarrow{\text{CE}} \text{Cholesterol + Fatty acid}$$

$$\text{Cholesterol} + O_2 \xrightarrow{\text{CO}} \text{Cholestene-3-one} + H_2O_2$$

$$2H_2O_2 + \text{4-AAP} + \text{Phenol} \xrightarrow{\text{Peroxidase}} \text{Quinoneimine} + H_2O$$

The Synchron CX system automatically proportions the appropriate sample and reagent volumes into the cuvette, where the ratio used is one part sample to 100 parts reagent. The system (CX7) monitors the change in absorbance at 520 nanometres. Such change in absorbance is directly proportional to the concentration of cholesterol in the sample and is used by the system (CX7 instrument) to calculate and express the cholesterol concentration.

High density lipoprotein-cholesterol (HDL-c)

Two HDL cholesterol reagent cartridges (2 x 300 tests), CX HDL cholesterol calibrator, two levels of control material and saline were used for the quantitative determination of HDL-c in serum. Acceptable reagent performance was measured by successful calibration and by ensuring that quality control results are within our facilities acceptance criteria. The HDL cholesterol reagent cartridge was calibrated every 14 days and also calibrated after changing new reagent cartridge, in addition to two levels of control material were analysed daily.

Low density lipoprotein (LDL) and very low density lipoprotein (VLDL) cholesterol can be precipitated by dextran sulfate (50,000 Mw) and magnesium in the separating reagent (Assmann *et al.*, 1974). The LDL and VLDL portions are then removed by centrifugation. The cholesterol in the HDL fraction which remains in the supernatant is assayed with an enzymatic cholesterol reagent.

HDL cholesterol reagent is used to measure the cholesterol concentration by a timed endpoint method (Allain *et al.*, 1974). In the reaction, the cholesterol esterase (CE) hydrolyses cholesterol esters to free cholesterol and fatty acids. The free cholesterol is oxidised to cholestene-3-one and hydrogen peroxide by cholesterol oxidase (CO). Peroxidase (HPO) catalyses the reaction of hydrogen peroxide with 4-aminoantipyrine (4-AAP) and phenol to produce a colored quinoneimine product, see please previous cholesterol reaction scheme.

The Synchron CX system automatically proportions the appropriate HDL cholesterol sample and reagent volumes into a cuvette, where the ratio used is one part sample to 60 parts reagent. The system (CX7) monitors the change in absorbance at 520 nanometres. Such change in absorbance is directly proportional to the concentration of cholesterol in the sample and is used by the system (CX7 instrument) to calculate and express the HDL-cholesterol concentration.

Magnesium (Mg)

Two magnesium reagent cartridges (2 x 100 tests), CX multi calibrator, two levels of control material and saline were used for the quantitative determination of magnesium in serum by Synchron CX Delta Systems. Acceptable reagent performance was measured by successful calibration and by ensuring that quality control results are within our facilities acceptance criteria. The magnesium reagent cartridge was calibrated every 7 days and also calibrated after changing new reagent cartridge, in addition to two levels of control material, normal and abnormal, were analysed.

Magnesium reagent is used to measure the magnesium concentration by a timed endpoint method (Abernathy & Fowler, 1982). Magnesium combines with calmagite to form a stable chromogen, where the product is formed rapidly giving reproducible results with a minimum of interferences, according to the following chemical reaction:

$$\text{Calmagite} + Mg^{++} \longrightarrow Mg^{++}\text{ - Calmagite Complex}$$

The instrument automatically proportions the suitable sample and reagent volumes into a cuvette, where the ratio used is one part sample to 103 parts reagent. The system (CX7) monitors the change in absorbance at 520 nanometres. Such change in absorbance is directly proportional to the concentration of magnesium in the sample and is used by the system (CX7 instrument) to compute and express the magnesium concentration.

Iron (Fe)

Two iron reagent cartridges (2 x 200 tests), Synchron System IRON/TIBC calibrator kit, two levels of control material and saline were used for the quantitative determination of iron in serum by Synchron CX Delta Systems. Acceptable reagent performance was measured by successful calibration and by ensuring that quality control results are within our facilities acceptance criteria. The iron reagent cartridge was calibrated every 14 days and also calibrated after changing new reagent cartridge, in addition to two levels of control material, normal and abnormal, were analysed daily.

Iron reagent is used to measure the iron concentration by a timed endpoint method. In the reaction, acetic acid released iron from transferrin and then is reduced to the ferrous state by hydroxylamine and thioglycolate. The ferrous ion in which is formed is immediately complexed with the Ferrozine Iron Reagent, see the following chemical reaction scheme:

Transferrin-$(Fe^{3+})_2$	Acetic acid pH 4.3 $\longrightarrow$	Transferrin + $2Fe^{3+}$
Fe^{3+} + Hydroxylamine + Thioglycolate	$\longrightarrow$	Fe^{2+}
Fe^{2+} + 3FerroZine	$\longrightarrow$	Fe^{2+} + $(FerroZine)_3$

The Synchron CX system automatically proportions the appropriate sample and reagent volumes into a cuvette, where the ratio used is one part sample to 8 parts reagent. The system (CX7) monitors the change in absorbance at 560 nanometres. Such change in absorbance is directly proportional to the concentration of iron in the sample and is used by the system (CX7 instrument) to compute and express the iron concentration.

3.2.4.2 Sysmex SF-3000 Instrument

The instrument is computerised, fully automated haematology analyser with many features, for in vitro diagnostic use in clinical laboratories. It provides accurate and precise 23-parameter haematology results essential in diagnosis and therapeutic monitoring of patients (Sysmex web site, 2002). The SF-3000 shows two major systems, Main Unit and Pneumatic Unit. The Main Unit houses the hydraulic and electronic systems and their control components, which analyses, processes and displays the data on the colour liquid crystal display (LCD) screen. The second part is Pneumatic Unit, supplies the require pressure and vacuum for analysis.

SF-3000 has the ability of analysing up to 80 samples per hour, including 23 analysis data parameters on the LCD screen. The 23 parameters are analysed by 4 detection methods and 5 types of reagents. Haemoglobin (Hb) determination is performed using the

Sulfolyser (SLS) haemoglobin detection method (Sysmex, 1995). Sysmex (1995) explain the Hb analysis flow as following:

1. The whole blood is aspirated from the whole blood aspiration tube to the sample rotor valve.
2. The 3.0 μL sample, which is measured by the sample rotor valve, is diluted to 1:333 with 0.997 mL of diluent (CELLPACK). The diluted sample is then sent to the flow cell. At the same time, 0.5 mL of the reagent used for Hb determination (Sulfolyser) is added to hemolyse the red cells and transform haemoglobin into SLS- haemoglobin. The final dilution ratio is 1:500.
3. The light released at a 555 nm wavelength from the photo diode passes through the lens and is directed at the sample in the flow cell. The concentration of the SLS-haemoglobin is measured by its absorbance of light, as compared to the absorbance of the diluent (blank) measured before the sample entered the flow cell.

3.3 Statistical analysis

The data was analysed using Microsoft excel professional program 2003. Statistical Package for Social Science research (SPSS, version 10, for Windows, 1999) was also used for statistical analysis of socio-demographic variables, health habits, dietary and physical activity, anthropometric indicators, and biochemical values. Data are presented as means, standard deviation and standard error of means (when appropriate), and 95% confidence interval for all different variables. The mean values of weight, height, and BMI obtained in this study were compared with those of a study conducted by Eid *et al.* (1986) studying 1984. Pooled means of body mass index data for each age group were plotted against the reference curve of Cole *et al.* (2000), Magbool (1994), and NCSH/CDC reference population for boys and girls to compare with the study population. Statistical comparisons between boys and girls were done using un-paired-samples t-test with p-values <0.05 used as cut-off for statistical significance. The significant difference between age groups and gender were also confirmed by ANOVA single factor test. Similarly, energy intake and energy expenditure, physical activity levels, health habits and biochemical variations were compared. Risk of the metabolic syndrome (syndrome X) among males and females Kuwaiti school children aged 6 – 13 year was assessed by the estimation of glucose (Glu), triglycerides (TG), and high density lipoprotein cholesterol (HDL-c) serum levels.

Comparisons were made between biochemical values obtained and appropriate age-specific normative or reference limits used in Kuwait. Pearson's product moment correlation test was done to test for any association among exposure variables and Student's t-test used to test significance of any differences found between age groups and gender.

3.4 Ethical considerations

This study was conducted with the approval of the appropriate authorities at the Ministry of Health, Kuwait. The study protocol was approved by the Ethics Committee of the Kuwait Institute for Medical Specialisation Studies and Research Unit (KIMS) at the Ministry of Health (Appendix 6). The education authorities in the schools in different governorates, parents and school children were duly informed and gave their consent before the subjects were included in the study. All information relating to this work is held in strict confidence and anonymity is assured. All data is held solely for the purposes of this scientific research.

CHAPTER 4: Results of Health and dietary habits-related behaviour

4.1 Introduction

This chapter focuses on lifestyle and socio-demographic characteristics of the study population and how these factors influence food-related behaviour. This part of the investigation of school-age children in Kuwait was aimed at examining the potential environmental exposure variables which may pose short and long term individual and public health challenges for this population.

A structured and pre-tested questionnaire was administered to the study participants to obtain information on their socioeconomic background, family size, parental academic qualifications and income, health habits, lifestyle, and food preferences and eating habits.

4.2 Socio-demographic and sample characteristics of subjects

Table 4.1 below provides a summary of classification of the sample population from all six governorates of Kuwait. From the 48 schools selected (24 primary and 24 intermediate schools) a total of 1536 students representing 6.7% of the total number of school children at these schools matched for age and gender were chosen. The detailed sampling procedure of which has previously been described in the methodology chapter (chapter 3).

Table 4.1 Sample population distribution according to gender and age groups selected randomly from 48 schools in six governorates in Kuwait

	Schools			Students		
	Boys	Girls	Total	Boys	Girls	Total
Primary (6–9 years)	12	12	24	384	384	768
Intermediate (10–13 years)	12	12	24	384	384	768
Total	24	24	48	768	768	1536

Kuwait is small country and all the six governorates are close to each other (quite continuous without clear borders). Thirty-seven percent of subjects had three or less siblings and 63% who had four or more siblings in their household. This compares to 76.3% with 4 or more siblings in a previous study in Kuwait (Moussa *et al.*, 1999). The majority of parents had at least secondary education with 73% of men and 81.5% of women being educated up to or above secondary level. The latter finding is also significantly higher than previous findings of 53.3% of females (Table 4.2a). In terms of net family income, only 29 % of families earned 500 KD or below (i.e. the equivalent of 1000 UK Pounds Sterling) per month. Over 70% of the sample population reported net monthly family incomes above 500 KD, i.e. above £1000 with 11.7 % earning above the equivalent of £ 2000 or more (see Appendix 7).

Table 4.2a Socio-demographic characteristics by percentage (%) of 1536 Kuwaiti school children aged 6 to 13 years (A) versus findings of Moussa *et al.* (1999) study (B)

Characteristics	A*	B**
No. of siblings		
0 – 3	37.6	23.7
≥ 4	62.5	76.3
Parental Education		
Father:		
Secondary	40.0	32.9
University and above	32.9	31.1
Mother:		
Secondary	32.1	28.0
University and above	49.4	25.3
Social class (Net Monthly Income)		
Moderate (>500 KD ≤ 1000 KD)	59.4	56.4
High (> 1000 KD)	11.7	7.2

* Current study; ** Moussa *et al.* (1999) study.

Furthermore, families in this study demonstrated improvements in socio-economic status based on net family income with a shift of 7.5% from low to moderate; and by 4.5% from moderate to a high income class compared to previous findings (Moussa *et al.* 1999) (Table 4.2a). The socio-demographic indicators in the present study provide some evidences of an economic transition among this cohort of Kuwaiti school children (Table 4.2b).

Table 4.2b Socio-demographic indicators providing evidence of economic transition among this cohort of 1536 Kuwaiti school children

Characteristics	**Change (A/B)**	**Comments**
Small family size		
No. of siblings (0-3)	1.58-fold	from 23.7 to 37.6%
Parental Education		
Father:		
Secondary and above	1.14-fold	from 64.0 to 72.9%
Mother:		
Secondary and above	1.53-fold	from 53.3 to 81.5%
Net Monthly Family Income (KD)		
Moderate and high social class (> 500 KD)	1.12-fold	from 63.6 to 71.1%

4.3 Lifestyle and habits

Of the total number of 1536 subjects, only 90 (11.7%) boys and 28 (3.6%) of girls reported walking to school i.e. an average of 7.7%, with over 92% of subjects going to school by private transport (Table 4.3). Similarly, just under 290 (38%) of boys and 124 (16.1%) of girls in all age groups undertake any significant walking to outdoor or leisure centres. The results also show that 26.7% of boys and 9.9% of girls undertake exercise of two hours' duration or more with only 173 subjects (11.3%) undertaking strenuous exercise of any kind. Sixty one percent of boys enjoyed exercise, compared to 38.7 percent of girls who reported enjoying exercise. However, only 114 (14.8%) boys and 49 (6.4%) girls would exercise during hot weather i.e. on average 10.6%; and over 43% and 21% of the subjects slept eight hours or less during school days and holidays, respectively. Overall, 65.3% of total subjects enjoy playing with others, if they had the chance. The majority of subjects spent their leisure hours watching television or playing computer games (82%) several hours a day.

With regards to food and eating habits, 240 (31.2%) boys and 243 (31.6%) girls reported fixed meal times. An average of 66.6% of subjects had breakfast as part of their daily diet with 551 (71.7%) and 472 (61.5%) of boys and girls respectively having breakfast daily. However, the figures indicate that nearly 29% of boys and 39% of girls skip breakfast. Of the total number of boys and girls in each gender group across all ages in the study, four hundred and thirty four boys (i.e. 56% of the male sample population) and four hundred and eighty five of girls (i.e. 63.1% of the female sample population) regularly enjoy and rely on fast (convenience) foods with only 135 (17.6%) of boys and 96 (12.5%) of girls respectively avoiding (or trying to avoid) these foods. Furthermore, 45% of all the school children reported eating when there was no real need for food. Only 179 (11.6%) of the subjects always ate at the dinner place; while only 35.3% liked to share their food with others. The majority of the school children (93.5 %) did not focus on food during the mealtime.

Media advertising of food appeared to play a part in food choice and habits with 616 (80.2%) of boys and 665 (86.6%) of girls likely to select foods similar to those advertised on TV. Furthermore, over seventy five percent (1153 subjects) of Kuwaiti school children were attracted by restaurant advertisements and the toys and other tokens that were introduced by fast food restaurants. Similarly, peer influences seemed to be important in food choice with 1067 (69.5%) of all subjects in the study likely to have similar food as that consumed by their friends (Table 4.3).

Parental influence in food preference and choice was reported by only 420 subjects i.e. 27.3% of the total sample population. Similarly, only 57 subjects (3.7% of sample population) followed a diet plan recommended by a doctor or dietician. There was little interest in governmental dietary programmes with just 56 boys (7.3% of male sample) and 103 girls (13.4% of female sample) reporting an interest in schools or governmental dietary programmes.

Table 4.3: Showing selected physical activity and other health habits of 1536 Kuwaiti school children aged 6 – 13 years

Variables	Response Rates					
	Boys		Girls		Total	
	N	(%)	N	(%)	N	(%)
• Physical Activity						
- Walking:						
School	90	11.7	28	3.6	118	7.7
Outdoors / leisure	290	37.8	124	16.1	414	26.9
- Exercise Type & Frequency:						
Duration ≥ 2hrs/day	205	26.7	76	9.9	281	18.3
Performing of hard exercise	152	19.8	21	2.7	173	11.3
• Sport & Leisure Interests						
- Enjoyment of exercise	470	61.2	297	38.7	767	49.9
- Enjoyment of group play	449	58.5	554	72.1	1003	65.3
- Exercising during hot weather	114	14.8	49	6.4	163	10.6
- Hours of TV viewing ≤ 1hr / day	171	22.3	100	13.0	271	17.6
• Sleeping habits ≤ 8 hours						
- During school days	303	39.4	367	47.8	670	43.6
- During holidays	151	19.7	179	23.3	330	21.5
• Food habits and eating-related behaviours						
- Fixed meal times	240	31.2	243	31.6	483	31.4
- Daily breakfast consumption	551	71.7	472	61.5	1023	66.6
- Daily consumption of fast foods	434	56.5	485	63.1	919	59.8
- Total avoidance of fast foods	135	17.6	96	12.5	231	15.0
- Daily including vegetables in meals	248	32.3	229	29.8	477	31.0
- Eating without real need to food	351	45.7	338	44.0	689	44.9
- Eating while sitting at dinner place	98	12.8	81	10.5	179	11.6
- Eating while watching TV or other focus	729	94.9	708	92.2	1437	93.5
- Eating with others	249	32.4	294	38.3	543	35.3
• Food habits-related effects						
- TV	616	80.2	665	86.6	1281	83.4
- Friends	523	68.1	544	70.8	1067	69.5
- Parents	215	28.0	205	26.7	420	27.3
- Doctor or dietician	40	5.2	17	2.2	57	3.7
- Schools or government programs	56	7.3	103	13.4	159	10.3
- Restaurants advertisements and toys	546	71.1	607	79.0	1153	75.1

4.4 Assessment of predictors of unhealthy habits and behaviours which are proxy predictors of overweight and / or obesity

A list of 19 habits and behaviours which have been postulated as predictors of obesity risk among children (Cornelius, 1991; Koletzko *et al.*, 2002; Wake *et al.*, 2003; Caroli *et al.*, 2004; Serra-Majem *et al.*, 2006) and included in the questionnaire on health habits and lifestyle (described in sections 2 and 3, please see appendix 2) were analysed. The prevalence of these 19 habits and behaviours are shown by Table 4.4.

The findings show that the prevalence of "always eating while watching TV or other focus" was the highest among boys and "always using car to school", highest among girls. The prevalence of "irregularly eating breakfast" was lowest among boys and "not always enjoy group play" highest among girls. Overall, the prevalence of such habits and behaviours was estimated at 64.1% (95% CI 54.5, 73.6) for boys and 68.4% (95% CI 58.2, 78.6) for girls with an overall mean value of 66.3% (95% CI 56.7, 75.8) for the sample population. Statistically, no significant difference was found between boys and girls (p=0.071). The pooled average response rates of these habits and behaviours, as one group, give an early indication of risk of overweight and obesity among this cohort. These observations however need to be examined against other risks and measures of obesity risk such as the body mass index (BMI), skinfold thickness (SFT) and girth (e.g. WHR).

Table 4.4: Prevalence (%) of 19 habits and behaviours as predictors of overweight and/or obesity among 1536 Kuwaiti school children

Habits and behaviours (predictors)	Male	Female	Total
Always using car to school	88.3	96.1	92.2
Not always undertake outdoor activity	62.2	83.9	73.0
Exercise duration < 2 hours/day	73.3	90.1	81.7
Nature of exercise performance (Never and/or daily simple exercises only)	51.2	66.4	58.8
Not always enjoy in exercise	38.8	61.3	50.1
Not always enjoy group play	41.5	27.9	34.7
Irregular exercising in hot weather	85.2	93.6	89.4
Daily TV viewing ≥ 2 hours	37.2	36.8	37.0
Sleeping of school days > 8 hours	60.5	52.2	56.4
Sleeping of holidays > 8 hours	80.3	76.7	78.5
Irregular eating in fixed times	68.8	68.4	68.6
Irregular eating breakfast	28.3	38.5	33.4
Daily eating of fast food	56.5	63.2	59.8
Not always avoid fast food	82.4	87.5	85.0
Irregular vegetables consumption	67.7	70.2	68.9
Always eating without real need	45.7	44.0	44.9
Irregular eating at dinner place	87.2	89.5	88.3
Always eating while watching TV or other focus	94.9	92.2	93.6
Not always eating with others	67.6	61.7	64.6
% (95% CI)	64.1 (54.6, 73.6)	68.4 (58.2, 78.6)	66.3 (56.7, 75.8)

4.5 Discussion

Among factors associated with childhood obesity, socio-demographic indicators such as number of live siblings, parental education, and net monthly income have been implicated as exposure risk factors in different populations. However, these may vary from one population to another. A study by Maffeis *et al.* (1994) provided strong links between socio-demographic exposure variables and risk of childhood obesity in Italy, whereas Lissau & Sorensen (1992) contradicted such assertions. In the Kuwaiti context, socio-demographic variables examined in this study provide evidence of a socio-economic transition with improving income levels and parental education, particularly among women. Other factors such as religious and tribal affiliations, locality and position of parents in the government may be required in order to make a more definitive judgment on socio-demographic classification of the school-age Kuwaiti child (Moussa *et al.*, (1999). These early observations however also provide a basis for making comparative links between socio-demographic factors, lifestyle and body composition among school-age children in a country in economic transition such as Kuwait.

The results suggest the existence risk factors that increase food consumption including the influence of peer groups, the media and restaurants through advertising and the use of gifts and tokens to attract young clients. There are also behaviours which result in a decrease in the levels of physical activity among Kuwaiti school children including longer hours of leisure spent watching television and / or playing video games and overreliance on motor vehicles to go to school. Incidentally, these 'luxuries' which now appear to be routine practices were not available to similar cohorts of school children in Kuwait 20 years earlier.

According to Cornelius (1991) the appropriate estimated sleeping hours for children 6 to 13 years old is seven to eight hours. However, over fifty six per cent of the subjects in this study said they slept for more than eight hours in a day. This may be due to the fact school-children in this part of the world are used to sleeping the afternoon besides during the night. Jeya *et al.* (2004) reported that for adolescent females in UAE sleeping was the predominant "activity" during schooldays and on the weekend between 13:00–16:30.

The findings also suggested that the habit of inconsistent meal times, eating when there is no real need for food, eating without sitting at dinner place, eating without sharing and related behaviour is widespread among Kuwaiti children. For example, the results showed 93.5% of the subjects ate while focusing on something else (e.g. TV). This implies that individuals may consume more food with no control. Literature suggests that children's obesity-promoting dietary behaviour is affected by opportunities to share family meals (Gillman *et al.*, 2000) and by the amount and timing of television exposure (Saelens *et al.*, 2002; Wake *et al.*, 2003; Caroli *et al.*, 2004).

These findings of food related behaviour and drivers of physical inactivity among these subjects provide information which when analysed alongside physical, physiological and biochemical measures of risk of overweight, obesity and the metabolic syndrome, should provide an objective basis for an understanding of the underlying risk factors for obesity in Kuwait children and provide the basis for designing a framework to tackle the risk factors as part of primary preventive measures as suggested by Hursti (1999) and Mela (1999).

4.6 Conclusion

The current study has revealed a tendency towards a sedentary lifestyle among Kuwaiti school children in addition to the unhealthy behaviours that related to food choice which cannot be ignored in any public health strategies. These 'environmental risks are additional to existing genetic predispositions which may relate to the thrifty phenotype and genotype hypotheses (Hales & Barker, 1992) and so compound underlying genetic risk of obesity in a population such as this. These will form part of the overall discussion.

CHAPTER 5: Assessment of dietary intake and physical activity

5.1 Introduction

Energy balance is an important determinant of risk of overweight and obesity. A study of its components and determinants is therefore imperative in attempting to ascertain the underlying contributors to obesity in an individual. In the present study, dietary intake was measured among a sub-sample of the total sample population and total daily energy expenditure estimated from physical activity diaries and the use of standard prediction equations. The focus of this chapter is to present findings of an assessment of energy balance based on the estimates of total daily energy intakes (TEI) and total daily energy expenditure (TEE). The main objective was to attempt to predict risks of overweight and obesity based on energy balance.

5.2 Methodology

The detailed methodology has already been described in chapter 3 of this thesis. In this section a brief explanation is provided on the practical work of this chapter. Dietary intake and physical activity were conducted on a sub-sample of 194 Kuwaiti school children (99 males and 95 females) and both were completed with parents'.

Dietary intake was estimated using a 7-day dietary record of all foods, drinks and sweets consumed by subjects and analysed for energy and nutrient content. All dietary records were completed by subjects with the help of parents / guardians (and school teachers where appropriate). Data obtained were collated and then subjected to energy and nutrient analysis using standard food composition reference data. Energy and nutrient intakes in the present study were then compared with the UK dietary reference values, Committee on Medical Aspects of Food Policy (COMA) (Department of Health, 2003).

Physical activity was estimated from one week activity diaries kept by each subject in which all activities including sleep and play time, school and home leisure activities were recorded with the help of parents / guardians (and school teachers where appropriate). The averages of 7 days' activities matched to the days selected for food intake analysis were then collated for further analysis. Information from physical activity diaries was matched with existing reference physical activity ratios (PAR) (Department of Health, 2003).

Furthermore total energy expenditure and basal energy expenditure were derived using the Schofield and WHO prediction equations. Physical activity level (PAL was then calculated from the ratio of TEE / BMR.

Data in this section are presented as means, standard deviation and standard error of means where appropriate. Comparisons are made between TEE vs. TEI; TEI/BMR vs. TEE/BMR (PAL); and TEI vs. PAR employing Pearson's product moment correlation test in order to test any associations. Tests of statistical significance were carried out to establish any differences between the above variables and any gender differences employing un-paired-samples t-test with p-values <0.05 used as cut-off for statistical significance. The significant difference between age groups and gender were also confirmed by ANOVA single factor test.

5.3 Results

5.3.1 Food choice and utilisation of food groups

In order to give a better picture of food intake, Table 5.1 was developed to provide information on types and nature of food choices including food group categories frequently consumed by the sample population. The levels of consumption have been categorised into high (representing between 60%-100%); moderate (i.e. $\geq$ 40% - 59%) and low (< 40%) subject preference, respectively.

The most commonly consumed foods, chosen by over 80% of the subjects were white bread, Potato chips, Chocolate, and Cheese spread, followed by two kinds of traditional Kuwaiti dishes, Mcbous Dajaj (rice and chicken) and Khoubz (brown flat bread with sesame seeds) consumed by about 75% of children. Preference for other traditional dishes varied from 40% to 60%, except for Motabak Samak, a rice and fish dish, and Macaroni Bil Bashamil (macaroni with meat & white sauce) which were consumed by less than 35% and more than 65% of school children, respectively.

Over 55% of boys and 65% of girls ate eggs and Pizza, whilst, very few subjects preferred green salad (20.2% preference), citrus fruits (25.2% preference) and vegetables in both genders. Biscuits, whole milk, bananas, and corn flakes consumption decreased progressively with age for both males and females. Biscuits and whole milk were consumed by about 60% of subjects, whereas, bananas, and corn flakes were consumed by fewer than 40% of the whole group.

Preference for tea and carbonated soft drinks on the other hand, increased with age, with carbonated drinks consumption rising to 78% by age 13 years. Ice-cream consumption also increased with age, and was chosen by 67% of boys and 63% of girls respectively. Similarly, fast food such as Sausage McD, Chicken burger, Cheesburger-McD, and KFC-chicken side, were chosen by over 70% of Kuwaiti school children with intakes increasing with age.

Table 5.1 Percentages of consumers, by age and sex, of selected foods and drinks during the 7-day dietary record (n= 194 subjects; 99 males and 95 females)

	Males (age in years)			Females (age in years)			
Foods	6	7-10	11-13	6	7-10	11-13	Aver.
High Preference / Consumption (60%-100%)							
White bread	95	96	95	94	95	93	94.7
Cheese spread	86	92	94	89	95	93	91.5
Chocolate (snick, Aero, etc.)	93	90	87	91	89	86	89.3
Potato chips	86	88	91	83	82	87	86.2
Khoubz (brown flat bread with sesame seeds)	81	81	86	74	82	79	80.5
Chicken burger	78	79	84	76	80	82	79.8
Mcbous Dajaj (rice and chicken)	77	75	80	78	82	81	78.8
Cola (carbonated soft drinks)	76	77	83	75	78	79	78.0
Sausage McD	71	75	79	70	73	77	74.2
Cheesburger-McD	67	70	72	69	74	73	70.8
Kfc-chick side	64	71	74	69	71	72	70.2
Ice-cream	67	70	72	63	66	70	68.0
Macaroni Bil Bashamil (macaroni with meat & white sauce)	69	65	64	70	68	66	67.0
Eggs	63	55	57	66	69	68	63.0
Pizza	55	58	65	59	64	69	61.7
Dajaj Belferen (roasted chicken)	65	61	59	56	57	64	60.3
Moderate Preference / Consumption (40% - 59%)							
Whole milk	74	56	47	71	53	44	57.5
Marag Laham (meat stew)	57	53	49	54	58	58	54.8
Macbous Laham (spiced meat with rice and veg.)	59	50	52	55	53	57	54.3
Mahshi Warag Enab (stuffed grape leave with meat & veg.)	51	55	48	49	48	44	49.2
Kofta (minced meat and vegetables)	46	40	42	44	49	50	45.2
Momawash (rice and mung beans)	42	49	46	39	41	46	43.8
Low Preference / Consumption (≤ 40%)							
Corn flakes	44	39	30	38	32	27	35.0
Bananas	41	29	25	44	33	28	33.3
Motabak Samak (rice and fish)	29	33	34	31	30	34	31.8
Tea	23	27	33	24	36	39	30.3
Citrus Fruit	25	29	20	29	27	21	25.2
Green Salad	21	19	24	18	17	22	20.2

5.3.2 Energy intakes estimation

Data on total energy intake and nutrient content of foods consumed by the sample population are presented in Appendix 8. These are summarised according to gender, body weight, food weight, food energy, macronutrient and micronutrient (selected vitamins and minerals) intakes.

Boys were found to consume more energy than girls and consumption increased with age for both males and females (Figure 5.1). Statistical analysis showed that the differences in total daily energy intake between males and females, were not statistically significant in 6 year olds (p=0.08) and 11 to 13 year olds (p=0.12) but highly significant differences were reported among 7 to 10 year olds (p=0.005).

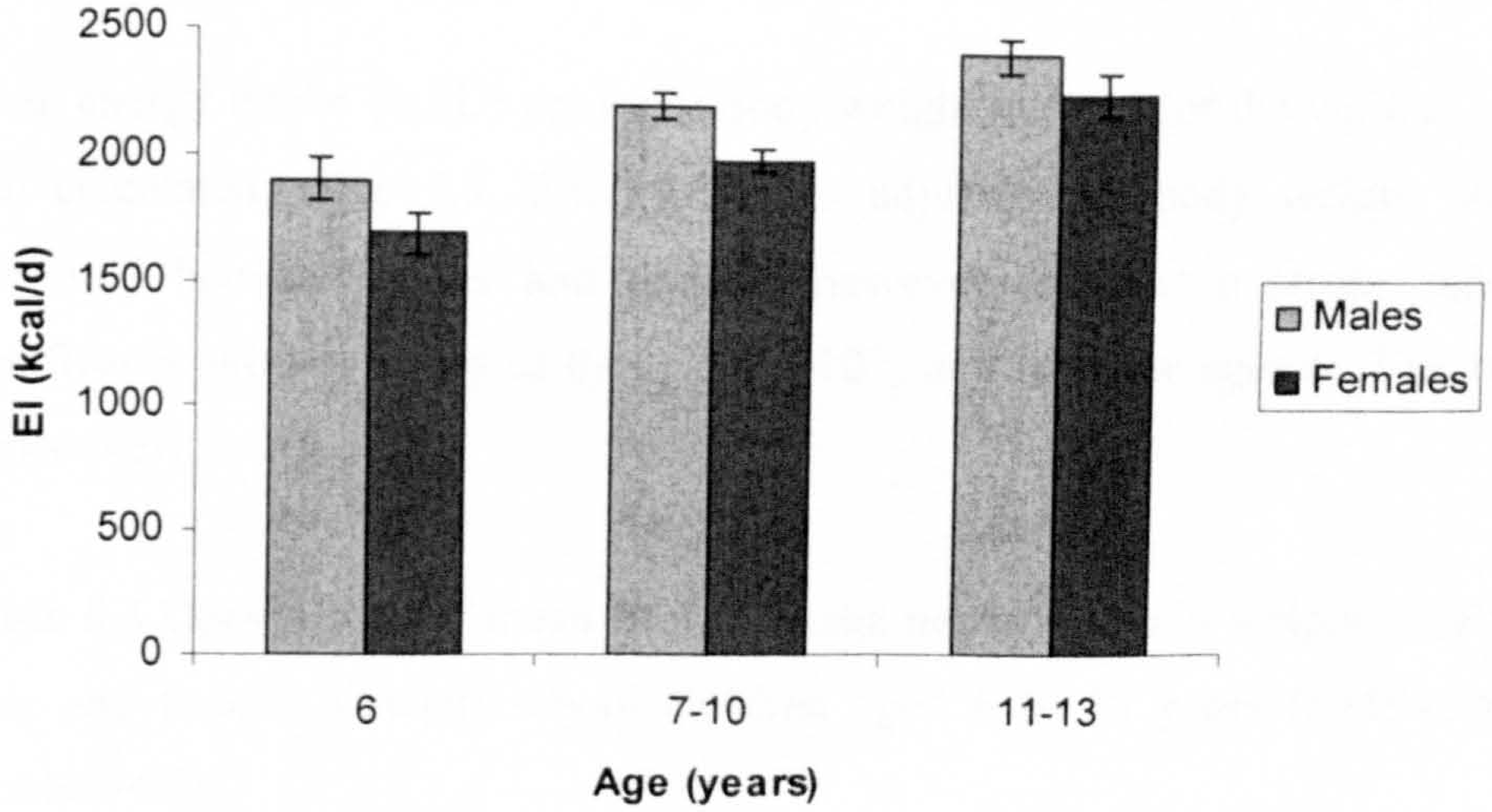


Figure 5.1 Mean energy intakes ±SEM (kcal/day) across the school age range among Kuwaiti children aged 6 to 13 year (n=194 subjects; 99 male and 95 female).

5.3.3 Energy intake in relation to age-specific requirements

The mean daily energy intakes (EI ±SD) for males and females in the three age groups as shown in Table 5.2 indicates that for all age groups, energy consumption exceeded the

EAR. This increase in energy consumption over EARs was highest (122%) among 11 to 13 year old girls and lowest among 11 to 13-year old boys.

Table 5.2 Mean daily energy intake (EI ±SD) among 6 to 13 year old Kuwaiti school children expressed as a percentage of estimated average requirements (EAR) (Department of Health, 2003)

Sex & Age (years)	Mean EI (±SD) kcal/d	EARs kcal/d	Percentage of EAR (%)
Males			
6	1903.3 (325.8)	1715	111.0
7-10	2194.2 (359.1)	1970	111.4
11-13	2408.8 (375.3)	2220	108.5
Females			
6	1696.5 (274.9)	1545	109.8
7-10	1993.3 (325.5)	1740	114.6
11-13	2255.4 (420.3)	1845	121.8

Mean energy intake (± SD) per kg of body weight per day for the various age groups were also calculated, table 5.3. Energy intakes adjusted for body weight (kcal/kg/d) when compared between males and females however, showed a strong tendency towards significance with p-values of 0.01, 2.7×10^{-5}, and 0.03 for ages 6, 7 to 10 and 11 to 13 respectively.

Table 5.3 Comparison of mean energy intake per kg of body weight (kcal/kg/d) between male and female Kuwaiti school children aged 6 to 13 years (n=194; males= 99 and females =95)

Age (years)	Males (± SD)	Females (± SD)	p-value
6	74.48 (8.53)	64.96 (10.21)	0.013
7 – 10	64.12 (12.96)	53.49 (10.74)	2.7×10^{-5}
11 – 13	49.04 (9.44)	44.94 (7.88)	0.033

The energy intakes adjusted for body weight (kcal/kg/d) can be used as an accurate index to calculate the extra energy consumption because such index (kcal/kg/d) is based not only on energy intakes among subjects but depends also on the effect of body weight of subject (i.e. the ratio of total daily energy intake to body weight), which was higher than those of

EAR values for UK population of similar age groups and provide extra evidence that the current subjects are consuming high energy.

5.3.4 The components of energy intake

5.3.4.1 Macronutrients consumption amount (g/d)

The intake of major macronutrients (fats, carbohydrates, and proteins) are summarised in Appendix 8. The intakes of macronutrients (g/d) increased with age for all sexes and age groups. The total mean amount of fat that was consumed by subjects in the current study on average equalled 85.9 g/d which is close to consumption levels among British adults (87.8 g/d). Saturated fat (SF) intakes for all age groups were also high and close to British adults' consumption. Similarly, carbohydrate intakes were high with mean (± SD) values varied from 230.3 (± 34.6) g/d and 193.8 (± 28.5) g/d at age 6 years to 271.2 (± 48.7) g/d and 252.4 (± 52.1) g/d at age group 10 – 13 year for males and females, respectively. On the other hand, protein intakes were high with mean (± SD) values varied from 76.4 (± 19.9) g/d and 73.0 (± 15.0) g/d at age 6 years to 91.8 (± 18.0) g/d and 100 (± 20.8) g/d at age group 10 – 13 year for males and females, respectively. These intakes of protein were far in exceeds of the RNI values.

5.3.4.2 Average percentage of energy derived from macronutrients consumption (Kcal/d)

The contributions of carbohydrates, proteins and fats were 45.9%, 16.4% and 37.2%, respectively, across all age groups compared to recommended intakes of 53%, 14.0% and 34.0% for carbohydrates, proteins and total fat, respectively (McDowell *et al.*, 1994) as illustrated in Figure 5.2. This figure provides a pie chart representing these contributions of the components of energy intake (A). These values have been compared with results of the Third National Health and Nutrition Examination Survey III (B).

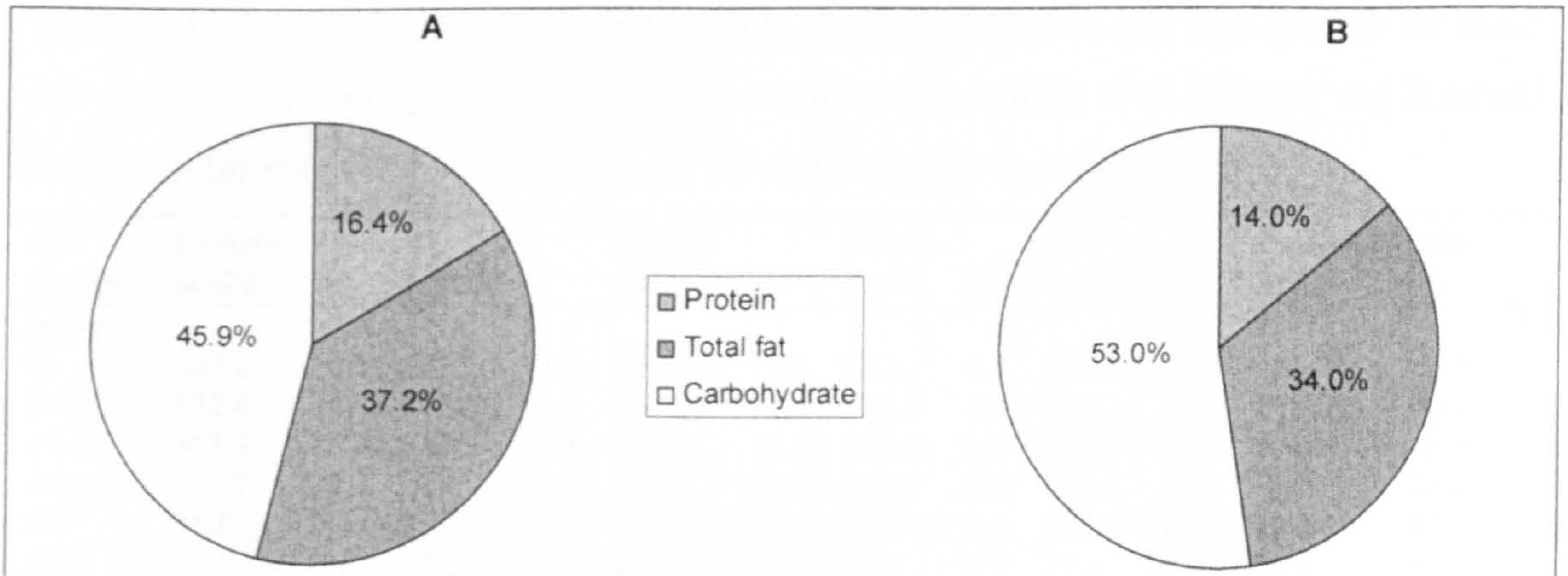


Figure 5.2 Mean (percent) values of the contribution of protein, total fat, and carbohydrate to daily energy intake among subjects (**A**) compared reference values based on data from NHANES III for individuals' ages 2 months to 19 years (**B**) (McDowell *et al.*, 1994 cited in Lee & Nieman, 2003).

In Table 5.4, macronutrient intake is expressed as percentages of carbohydrates, proteins and fats to total daily energy intake, presented for different age groups. Total fat consumed provided on average 808.5 (±123.1) kcal/d and 738 (±112.3) kcal/d for males and females, respectively. The average percentage of food energy derived from total fat was 37.2% for each sex. Saturated fatty acids (SF), mono-unsaturated fatty acids (MUF) and poly-unsaturated fatty acids (PUF), offered on average 14% (303 ±47.3 kcal/d), 12.9% (282.3 ±78.3 kcal/d) and 5.3% (115.8 ±29.8 kcal/d) of food energy respectively for boys and 12.8% (254.1 ±38.3 kcal/d), 11.3% (224.1 ±38.3 kcal/d) and 3.9% (77.7 ±18.5 kcal/d) respectively for girls.

The contribution of carbohydrates to energy intakes for all sexes and age groups provided on average, 46.6% (1008 ±82.3 kcal/d) for boys and 45.2% (894 ±117.2 kcal/d) for girls with an overall average of 45.9%. These values fall also below the COMA recommendations for adults of 50%. Similarly, the contribution of protein to energy intakes for all sexes and age groups provided on average, 15.3% (331.7 ±31.8 kcal/d) for boys and 17.5% (347.5 ±54.1 kcal/d) with an overall average of 16.4%.

Table 5.4 Mean daily macronutrient intakes (kcal/day) by sex and age (years) for three age groups and their percentages energy contribution among 6 to 13 year old Kuwaiti School children (n=194 school children; 99 males and 95 females)

Sex & Age	Protein kcal/d	%	SF kcal/d	%	MUFA kcal/d	%	PUFA kcal/d	%	TF kcal/d	%	Carbohydrate kcal/d	%
Male												
6	305.6	16.1	265.5	14.0	216.9	11.4	92.7	4.9	681.3	35.8	921.2	48.4
7-10	322.4	14.7	288.0	13.1	261.0	11.9	105.3	4.8	817.2	37.2	1018.0	46.4
11-13	367.2	15.2	356.4	14.8	369.0	15.3	149.4	6.2	927.0	38.5	1084.8	45.0
Average	331.7	15.3	303.3	14.0	282.3	12.9	115.8	5.3	808.5	37.2	1008.0	46.6
SD	31.8	0.7	47.3	0.9	78.3	2.1	29.8	0.8	123.1	1.4	82.3	1.7
SEM	18.4	0.4	27.3	0.5	45.2	1.2	17.2	0.5	71.1	0.8	47.5	1.0
Female												
6	292.0	17.2	216.9	12.8	184.5	10.9	60.3	3.6	636.3	37.5	775.2	45.7
7-10	350.4	17.6	252.0	12.6	226.8	11.4	75.6	3.8	719.1	36.1	897.2	45.0
11-13	400.0	17.7	293.4	13.0	261.0	11.6	97.2	4.3	858.6	38.1	1009.6	44.8
Average	347.5	17.5	254.1	12.8	224.1	11.3	77.7	3.9	738.0	37.2	894.0	45.2
SD	54.1	0.3	38.3	0.2	38.3	0.4	18.5	0.4	112.3	1.0	117.2	0.5
SEM	31.2	0.2	22.1	0.1	22.1	0.2	10.7	0.2	64.9	0.6	67.7	0.3

The protein intake values exceeded that of the RNI, for all males and females in all age groups (Table 5.5 and Figure 5.3). Protein intakes for boys varied by 1.8 to 2.7 times more than RNI per kg of body weight per day. Similarly, protein intakes for girls were varied by 2 to 2.5 times more than RNI per kg of body weight per day.

Table 5.5 Mean protein intake among 6 to 13 year old Kuwaiti school children compared to UK reference nutrient intake (RNI) values

Age (years) & sex	Current study values			Dietary reference values			X-times
	weight (±SD) kg	intake (±SD) g/d	intake (±SD) g/kg/d	weight kg	RNI g/d	RNI g/kg/d	
Males							
6	25.9 (3.0)	76.4 (19.9)	2.95 (0.77)	17.8	19.7	1.11	2.68
7 – 10	35.8 (8.5)	80.6 (19.6)	2.25 (0.55)	28.3	28.3	1.00	2.25
11 – 13	52.8 (12.8)	91.8 (18.0)	1.74 (0.34)	43.0	42.1	0.98	1.78
Females							
6	26.7 (3.9)	73.0 (15.0)	2.73 (0.56)	17.8	19.7	1.11	2.46
7 – 10	38.8 (7.7)	87.6 (14.0)	2.26 (0.36)	28.3	28.3	1.00	2.26
11 – 13	51.6 (8.7)	100.0 (20.8)	1.94 (0.40)	43.8	41.2	0.94	2.06

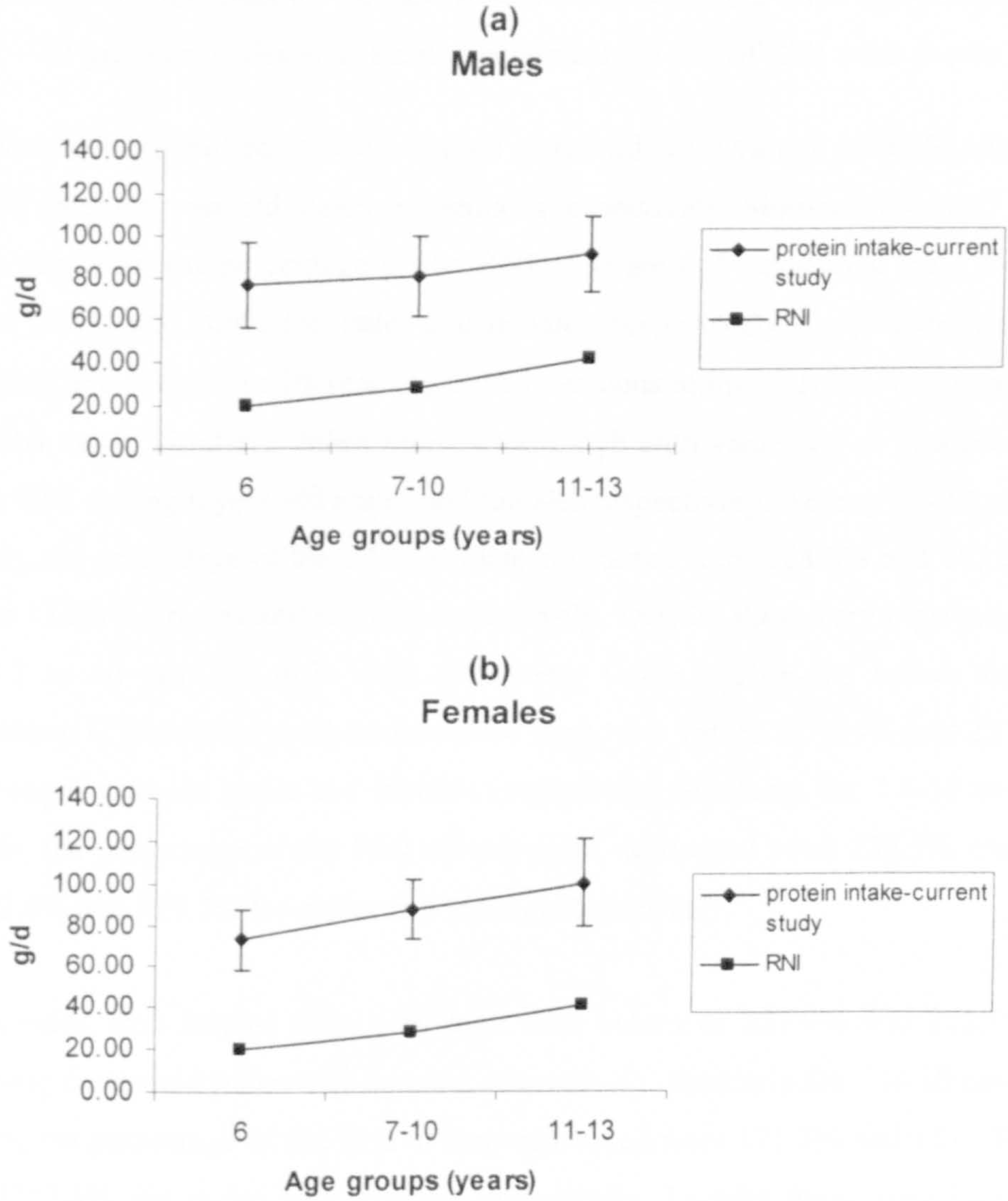


Figure 5.3 Comparison of mean protein intake (Mean ±SD g/d) among boys (**a**) and girls (**b**) aged 6, 7 to 10 and 11 to 13 years in Kuwait compared to age-matched reference nutrient intake (RNI) values (Department of Health, 2003).

5.3.5 Vitamin and mineral intakes

A summary of mean intakes (± SD), for each gender and age group, of a number of micronutrients including vitamin A (carotene), folate, ascorbate, iron, copper, selenium, magnesium and calcium were shown by Appendix 8, while, mean daily intakes of such vitamins and minerals by Kuwaiti school children for the three age groups (6, 7 – 10, and 11 – 13 year) for males and females as percentage (%) of RNI were shown by Table 5.6.

Vitamin A (retinol equivalent) intakes were high with values of 103% and 113.7% of the RNI among 6 year old males and females respectively. Similarly among 7 to 10 and 11 to 13 year olds, the percentage of the RNI of vitamin A consumed were 89% and108.8%; and 99.1% and 109% for males and females, respectively. Despite these very high mean values 8% of the 7 to 10-year old boys were consuming vitamin A equivalents below the LRNI value. Similarly, folate intakes were high with values for of 159.1% and 124.4% of the RNI among 6 year old males and females respectively. Among 7 – 10 and 11 – 13 year olds, the percentage of the RNI of folate consumed were 128.8% and 102.3%; and 99.7% and 116% for males and females respectively. Despite these very high mean values 6.5% of 7 to 10 year old girls were consuming folate equivalents below the LRNI value. Vitamin C (Ascorbic acid) intakes were high with values of 184% and 257% of the RNI among 6 year old males and females respectively. Similarly, for 7 – 10 and 11 – 13 year olds, the percentage of the RNI of vitamin C consumed were 232.3% and 281.7%; and 132.6% and 329.7% for males and females respectively.

Likewise, iron intakes were very high with values of 227.9% and 172.1% of the RNI among 6 year old males and females, respectively. Similarly for 7 to 10 and 11 to 13 year olds, the percentage of the RNI of iron consumed were 171.3% and 147.1%; and 134.5% and112.8% for males and females, respectively. Despite these very high mean values 3.5% of 11 to 13 year old girls were consuming iron equivalents below the LRNI value. Magnesium intakes were similarly very high with values of 275.6% and 171% of the RNI among 6 year old males and females respectively. Similarly for 7 to 10 and 11 to 13 year olds, the percentage of the RNI of magnesium consumed were 168.3% and 121.6%; and 145.4% and117% for males and females respectively. For selenium and copper, average intakes were found to be four times above the RNI in the 6 years old, and then, as other minerals intake decreased with age for boys and girls. Average intake of calcium as percentage of RNI for boys was reported to be 77.5% in age group 11 – 13 years, which was below the RNI by 22.5%, but above EAR by 3%. Dietary reference values (RNI, EAR, and LRNI) for the selected vitamins and minerals for three age groups, COMA (Department of Health, 2003), are shown in Appendix 9.

Table 5.6 Mean daily intakes of vitamins and minerals by 6 to 13 year old Kuwaiti school children expressed as percentages (%) of the Reference Nutrient Intakes (RNI) (Department of Health, 2003)

	Males			Females		
Vitamins& Minerals	6	7-10	11-13	6	7-10	11-13
Vitami A*	103	89*	99.1	113.7	108.8	109
Folate**	159.1	128.9	99.7	124.4	102.3**	116.6
Vitamin C	184	232.3	132.6	257	281.7	329.7
Selenium	420.5	276	247.5	273	208.7	178.7
Copper	416.7	357.1	237.5	316.7	285.7	287.5
Iron***	227.9	171.3	134.5	172.1	147.1	112.8***
Magnesium	275.6	168.3	145.4	171	121.6	117
Calcium	155.1	116.8	77.5	156.6	145.9	125.8

*8% of 7-10 years boys had vitamin A intakes below the LRNI; **6.5% of 7-10 years girls had folate intakes below the LRNI; and ***3.5% of 11-13 year girls had iron intakes below the LRNI.

5.3.6 Physical Activity

In Table 5.7 below, the overall results of physical activity assessments, in which the BMR were estimated by Schofield equations have been presented. Prediction equations were used to estimate basal metabolic rate (BMR). Physical activity ratios (PAR) were similarly determined using standard sources (UK Department of Health, 1991; 2003). Energy intakes (EI) were quantified from analysis of food record diaries and total energy expenditure (TEE) determined by physical activity records, the use of PARs and BMR. Average values (±SD) of BMR, PAR, EI, EI/BMR, TEE, and TEE/BMR (or PAL) were calculated, and then comparisons are made of various variables in Table 5.7.

Calculations for boys showed that the average BMR values increased with age for those 6 to 13 years old. Among girls, BMR values increased with age but a declined is reported in age 10 years. Average values (±SD) of BMR were 1384 (±244) and 1315 (±154) kcal/d for males and females aged 6 – 13 year old, respectively. Similarly, average values (±SD) of TEE, PAR, EI, EI/BMR, and TEE/BMR (or PAL) were calculated. Estimated total energy expenditure also showed an increase with age. Average of TEE (±SD) were 1797

(±252) and 1603 (±172) kcal/d for males and females, respectively. The averages of physical activity ratio (PAR) for each age group of school children were close to each other, PAR ≤ 2.0 for boys and approximately 1.9 for girls. Furthermore, the ratio of TEE to BMR or physical activity level (PAL) were reportedly less than the EI to BMR ratio for boys and girls in all age groups. Statistically, significant differences were found for all variables (BMR, TEE, PAR, EI, EI/BMR, and TEE/BMR), between males and females.

Table 5.7 Means and standard deviation values of basal metabolic rate (BMR), total energy expenditure (TEE), daily energy intake (EI), physical activity ratio (PAR), and ratios of energy expenditure and by energy intake relative to basal metabolic rate of 6 – 13 year old Kuwaiti school children (n=194; 99 males and 95 females)

Sex & Age (yrs)	N	BMR ±SD	PAR ±SD	EI ±SD	EI/BMR ±SD	TEE ±SD	TEE/BMR ±SD
Male							
6	16	1082 ±68	2.09 ±0.16	1903 ±326	1.76 ±0.27	1503 ±111	1.39 ±0.11
7	13	1197 ±110	2.03 ±0.17	2174 ±314	1.82 ±0.25	1618 ±152	1.36 ±0.11
8	14	1257 ±115	2.06 ±0.17	2111 ±400	1.67 ±0.24	1719 ±130	1.37 ±0.12
9	12	1299 ±147	2.05 ±0.20	2133 ±433	1.64 ±0.25	1763 ±142	1.37 ±0.14
10	12	1421 ±192	2.02 ±0.18	2375 ±230	1.69 ±0.22	1898 ±193	1.34 ±0.12
11	10	1463 ±182	1.97 ±0.24	2262 ±319	1.56 ±0.28	1899 ±98	1.31 ±0.16
12	11	1569 ±191	1.92 ±0.19	2438 ±399	1.56 ±0.26	1991 ±170	1.28 ±0.13
13	11	1680 ±252	1.97 ±0.27	2512 ±388	1.50 ±0.13	2176 ±203	1.31 ±0.18
	Average	1384 ±244	2.02 ±0.20	2117 ±394	1.66 ±0.25	1797 ±252	1.35 ±0.13
Female							
6	12	1099 ±89	1.94 ±0.16	1696 ±275	1.54 ±0.15	1408 ±179	1.28 ±0.10
7	11	1263 ±94	1.91 ±0.18	1834 ±234	1.45 ±0.14	1587 ±144	1.26 ±0.12
8	13	1327 ±154	1.96 ±0.28	1982 ±380	1.48 ±0.16	1695 ±133	1.29 ±0.18
9	12	1419 ±194	1.88 ±0.18	2016 ±325	1.42 ±0.11	1750 ±202	1.24 ±0.12
10	11	1277 ±93	1.81 ±0.16	2140 ±301	1.67 ±0.18	1520 ±126	1.19 ±0.10
11	12	1317 ±94	1.83 ±0.20	2170 ±364	1.64 ±0.19	1585 ±133	1.21 ±0.13
12	12	1369 ±81	1.78 ±0.17	2224 ±474	1.62 ±0.29	1603 ±87	1.18 ±0.11
13	12	1441 ±108	1.75 ±0.19	2372 ±426	1.63 ±0.19	1661 ±127	1.16 ±0.13
	Average	1315 ±154	1.86 ±0.20	2055 ±400	1.56 ±0.20	1603 ±172	1.23 ±0.13

In term of correlation, Pearson's moment correlation coefficient (r) was used. A positive correlation coefficient (Pearson) shows that as one variable increases, so does the other and visa versa for negative Pearson coefficient (Welton, 1999). For males, age had significant negative correlation with PAR (r = -0.236, significant at 0.05) and positive correlation with EI and TEE (significant at 0.01), r = 0.454 and 0.803 respectively.

Similarly, in females, age had significant negative correlation with PAR (r = -0.327, significant at 0.01) and positive correlation with EI and TEE (significant at 0.01 and 0.05, respectively), r = 0.504 and 0.204, respectively. Physical activity ratio (PAR) was negatively correlated with EI for both genders, r = -0.437 for males and -0.580 for females (significant at 0.01).

5.3.7 Comparisons of Energy Intake (EI) and Total Energy Expenditure (TEE)

Statistical analysis employing Student's t-test showed a strong tendency towards significance between energy intake (EI) and total energy expenditure (TEE), among all age groups (6 – 13 year) males and females, Table 5.8. These differences between EI and TEE for each age group and sex were more clarified by using mean values ± SEM, Figure 5.4, (a) and (b).

Table 5.8 Comparison and p-values of mean total daily energy intake (Mean ±SEM kcal/day) with age-matched mean total daily energy expenditure (Mean ±SEM kcal/day) among males and females aged 6 to 13 years in Kuwait

Sex & Age (yrs)	EI (± SEM)	TEE (± SEM)	p-value
Male			
6	1903 (± 81.5)	1503 (± 27.6)	1.8×10^{-3}
7	2174 (± 87.0)	1618 (± 42.1)	2.2×10^{-5}
8	2111 (± 107.9)	1719 (± 34.7)	0.003
9	2133 (± 125.0)	1763 (± 41.1)	0.014
10	2375 (± 66.4)	1898 (± 55.8)	1.6×10^{-5}
11	2262 (± 101.1)	1899 (± 30.8)	0.006
12	2438 (± 120.6)	1991 (± 51.2)	0.004
13	2512 (± 116.9)	2176 (± 61.1)	0.02
Female			
6	1696 (± 79.4)	1408 (± 51.7)	0.007
7	1834 (± 70.7)	1587 (± 43.4)	0.008
8	1982 (± 105.5)	1695 (± 37.0)	0.021
9	2016 (± 93.7)	1750 (± 58.4)	0.027
10	2140 (± 90.8)	1520 (± 38.1)	2.7×10^{-5}
11	2170 (± 104.9)	1585 (± 38.4)	1.3×10^{-3}
12	2224 (± 136.8)	1603 (± 25.0)	8.2×10^{-3}
13	2372 (± 123.0)	1661 (± 36.6)	9.7×10^{-5}

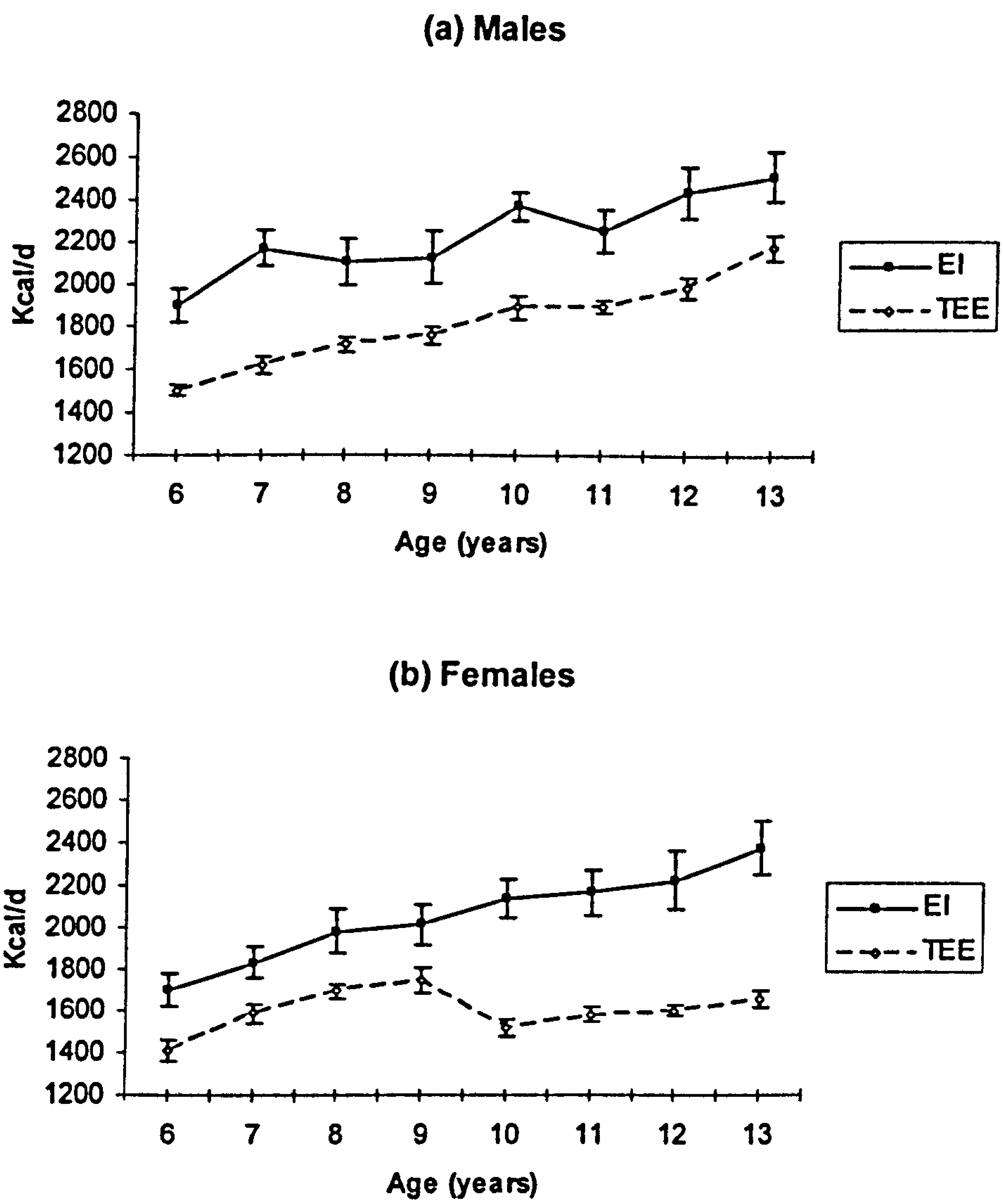


Figure 5.4 Mean energy intake (Mean ±SEM kcal/day) among males (a) and females (b) aged 6 to 13 years in Kuwait compared to age-matched mean total energy expenditure (Mean ±SEM kcal/day).

5.4 Discussion

The results of this chapter indicate a significant excess of energy intake (EI) over expenditure (TEE) in all age groups (Table 5.8 and Figure 5.4). These findings support the earlier findings which suggested a largely sedentary population with poor food choices.

The findings in chapter 4 suggested that over 70 percent of the typical school child's leisure time is spent watching TV or playing video games. From this study it is also evident that some of the most important reasons for increased intake of energy are frequent consumption of fast foods, high consumption of fat and protein. Such high intake of energy is not being offset by concomitant expenditure. Based on the criterion of Saris *et al.* (2003) who reported that a PAL of 1.4 would represent a sedentary individual, the subjects of this study can be considered only as sedentary (the average of PAL ±SD was 1.29 ±0.13). Several authors (Ferro-Luzzi and Martino, 1996; Steinbeck, 2001; Weinsier *et al.*, 2002; Westerterp & Kester, 2003) have observed that insufficient level of physical activity when combined with increased energy intake is a risk factor for persons being overweight or obese.

While the results have shown 6 – 13 year old Kuwaiti school children consume more energy per day than the estimated average requirements (EARs), leisure and occupational energy expenditure has declined considerably. Comparison as between TEI and TEE shows significant differences across all age groups in the sample population (Table 5.8). This a clear gap between TEI and TEE with a positive energy balance i.e. daily total energy intakes exceeded the daily total energy expenditure (Figure 5.4) is predicted to translate into changes in body fatness and increases in body weight and adiposity. The latter forms the main part of the findings reported in the next chapter. It is however becoming clearer that this population is in economic transition and with rising income levels and increasing wealth, children are assuming a more sedentary lifestyle accompanied by increased energy intake and poor food choices. These together form part of the dietary and environmental risk factors for obesity and the metabolic syndrome.

Components of EI

Taking a holistic view of energy intake components, the results of this study indicate the food habits of the subjects are skewed towards creating obesity and overweight. The results showed that on an average, carbohydrate contributed 46% of total daily energy intakes of the subjects. This was lower than the results obtained from the NHANES III study (53%) and below the COMA recommendations of 50%. Several researchers have suggested that diet composition, including high fat and low carbohydrate intakes, may play a role in overweight (Obarzanek *et al.*, 1994; Nguyen *et al.*, 1996; Maffeis *et al.*, 1996). Birch and Fisher (1998) reported that among adults and children, diets high in fat and low in complex carbohydrates are associated with greater adiposity. Protein intake of the subjects was also very high and reached 1.8 – 2.7 times the maximum daily requirement for similar age groups (Department of Health, 2003), see Table 5.5. In Western Europe and the United States, consumption of 1.5 to 2 times of the recommended protein intakes is currently considered to be harmless (Metges and Barth, 2000). Several researchers (Alfieri *et al.*, 1997 and Voss *et al.*, 1998) have reported a positive correlation between protein intake and BMI suggesting increased intake of protein may lead to obesity. Rolland-Cachera *et al.* (1995) reported that high protein intake increases body fatness at 8 years of age, via an early adiposity rebound. According to them high protein diet early in life could increase the risk of obesity and other pathologies later in life. Thus, it is reasonable to assume the subjects of this study are at risk of adiposity and overweight.

Micronutrient intakes

Estimates of vitamin and mineral intakes show that these were adequate and can be considered as evidence that the subjects under investigation are well nourished. Subjects of the study consumed vitamins and minerals well in excess of RNI values. Although, the amounts of their intake varied among age and sex, vitamin and mineral intakes remained higher than RNI in spite of the fact that vegetables and green salad were at the end of list of the subjects' option (see Table 5.1). Kuwaiti school children compensate this by consuming large quantities of other types of food which contain such vitamins and minerals. However, some subjects reported intakes below LRNI, such as vitamin A (8%), folate (6.5%), and iron (3.5%). Unless Kuwaiti school children consume fresh vegetables and green salad some of them will suffer from inadequate micronutrients. On the other hand, selenium and copper consumption were approximately four times of RNI values. These finding suggest that food habits of Kuwaiti school children need to be improved.

5.5 Conclusion

The study population is largely sedentary with low physical activity levels combined with increased positive energy balance. Thus, the findings in this chapter are indicative of two major environmental risk factors for overweight and obesity among Kuwaiti school children.

1. A sample population with high energy intake, especially high saturated fat (SF) and protein intake.
2. A largely sedentary lifestyle i.e. physical activity level on average equals 1.29 ±0.13 (PAL = 1.35 ±0.13 and 1.23 ±0.13 for males and females, respectively).

These findings and their wider implications will be examined in the chapter on overall discussion.

CHAPTER 6: Results of Anthropometric Measurements

6.1 Introduction

This chapter describes anthropometric measurements including weight (W), height (H), body mass index (BMI), waist to hip ratio (WHR), and skinfold thickness (SFT) for school children who completed a 7-days food and activity records in previous chapter. A sub-sample of 194 subjects (99 boys and 95 girls) were involved and the results provide information about current prevalence of overweight and obesity. The data has also been compared with previous findings (over the last 20 years) to ascertain any changing trends in an otherwise genetically homogenous population.

The rationale for employing multiple anthropometric measurements was to ascertain their individual effects on body fat and its link to risk factors and co-morbidities associated with overweight and obesity. In epidemiological studies, skinfold thickness (SFT) and waist circumference to hip circumference ratio (WHR) measurements have been used to assess body fat distribution. Both are excellent anthropometric measurements, they are uncomplicated and low costs tests (Wood *et al.*, 2003). The detailed methods and procedures were earlier described in chapter 3 of this thesis.

The main objective of this chapter is to present scientific data on anthropometric predictors of overweight, obesity and health risks among the same sample of the population, ascertain point prevalence of obesity and examine possible underlying predisposing factors including the impact of positive energy balance. An attempt has also been made to examine shifts in anthropometric characteristics of the school-age group in Kuwait over a 20 year period during which the country has undergone an epidemiological and nutritional transition. Data obtained have been compared with the NCHS normative references matched for gender and age, as well as the International BMI reference of Cole *et al* (2000) and local / regional data based on the work of Magbool (1994).

6.2 Results

6.2.1 Anthropometric variables

The mean values (M), standard deviations (SD), and standard error mean (SEM) of five anthropometric variables (weight, height, body mass index, waist to hip ratio, and skinfold thickness) are presented in Table 6.1. These are summarised according to age and gender. While mean WHR (± SEM) for the different age groups were close to each other, the data show increasing mean values for all anthropometric indicators with age except for the ΣSFT which slightly decreased at ages 7 and 8 years for boys. The range for weights (mean ±SEM) for ages 6 to 13 were 25.9 (± 0.75) to 58.8 (± 4.35) kg and 26.7 (± 1.14) to 57.0 (± 1.98) kg for males and females, respectively. Similarly, the height ranges from age 6 to 13 years (mean ± SEM) were 123.6 (± 0.83) to 158.6 (± 1.80) cm and 121.6 (± 1.29) to 155.5 (± 1.72) cm for males and females, respectively. BMI (mean ± SEM) varied from 16.9 (± 0.73) at age 6 years to 23.1 (± 1.20) kg/m^2 at age 13 years and from 17.9 (± 0.54) to 23.5 (± 0.71) kg/m^2 for males and females, respectively.

Statistical analysis employing Student's independent t-test for unpaired variables (confirmed by One-Way ANOVA procedure) showed that the differences between males and females aged 6 – 13 year old, were not statistically significant in weight (p=0.18) and in height (p=0.92) but highly significant differences were observed among school children in BMI (p=0.004) and in SFT (p=0.003). The differences in school children aged 6 – 13 year old between males and females were also significant in WHR (p=0.02).

BMI and SFT cut-off values that were compared to the current study values were shown in Appendix 10. However, to date there is no Waist to Hip Ratio (WHR) cut-off for young people. The SFT values of surveyed subjects were compared to one reference values, however, the BMI values were compared to three reference values. The international BMI cut-offs that were introduced by Cole *et al.* (2000) has shown the highest values followed by American reference population NCHS (2000) values.

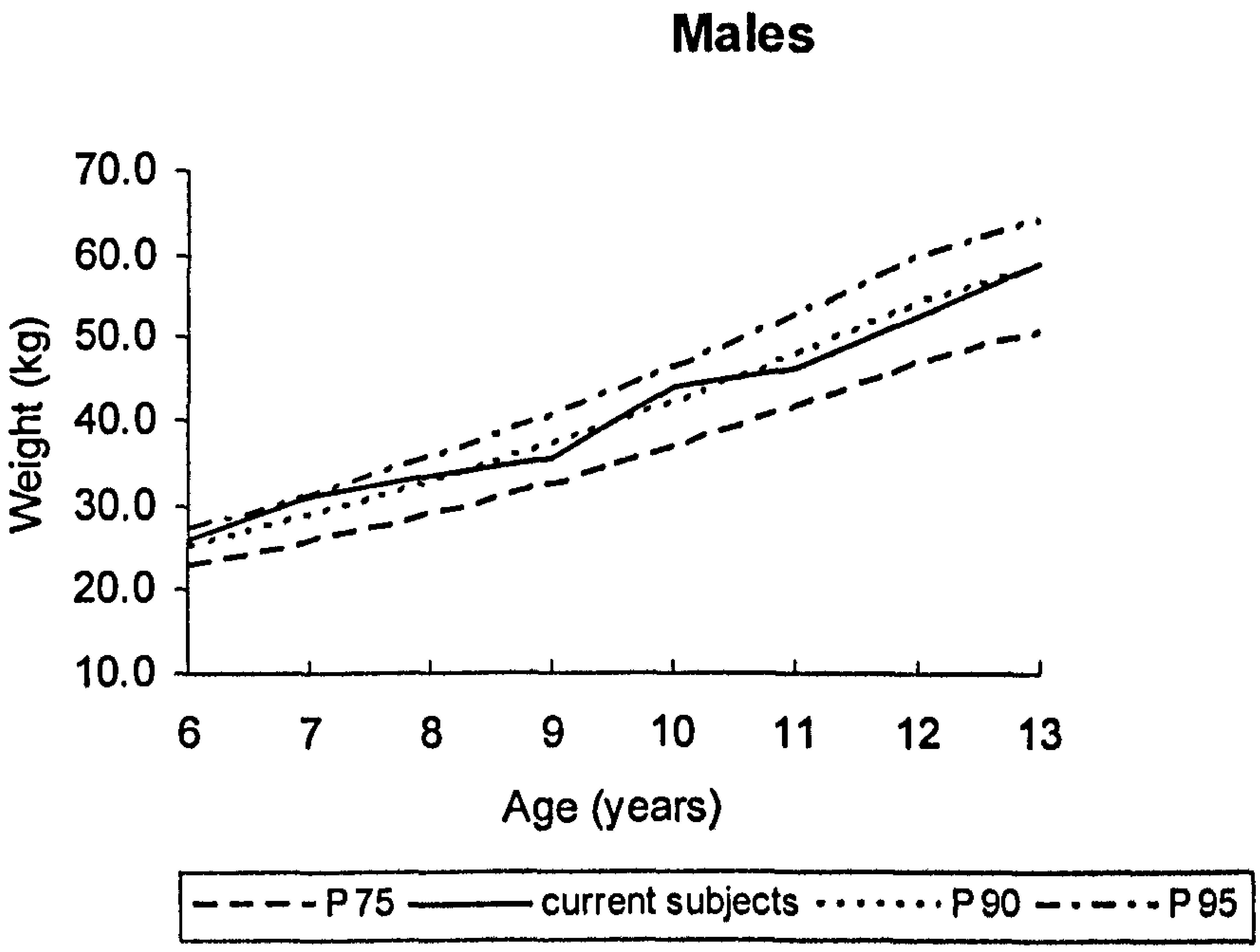
Table 6.1 Anthropometric variables in on 194 subjects of Kuwaiti schoolchildren (n =194 subjects; males =99 and females =95) matched by age and sex

Sex & Age (yrs)	n	Weight			Height			BMI			WHR			SFT		d
		Mean	*SD*	*SEM*	*Mean*	*SD*	*SEM*	*Mean*	*SD*	*SEM*	*Mean*	*SD*	*SEM*	*Mean*	*SD*	*SEM*
Males																
6	16	25.88	3.00	0.75	123.6	3.34	0.83	16.91	1.50	0.37	0.85	0.05	0.01	17.04	3.23	0.81
7	13	30.92	4.85	1.34	128.0	3.77	1.05	18.80	2.16	0.60	0.85	0.06	0.02	16.72	3.37	0.94
8	14	33.57	5.07	1.36	132.6	5.08	1.36	19.03	2.24	0.60	0.87	0.04	0.01	16.24	3.61	0.96
9	12	35.42	6.46	1.86	135.7	4.64	1.34	19.14	2.76	0.80	0.88	0.06	0.02	19.28	4.53	1.31
10	12	44.00	11.00	3.18	141.5	5.20	1.50	21.76	4.11	1.19	0.93	0.05	0.01	24.44	5.94	1.71
11	10	46.40	10.41	3.29	145.4	2.95	0.93	21.84	4.23	1.34	0.93	0.06	0.02	28.53	11.03	3.49
12	11	52.45	10.93	3.29	152.9	6.50	1.96	22.28	3.34	1.01	0.94	0.02	0.01	32.97	8.48	2.56
13	11	58.82	14.42	4.35	158.6	5.97	1.80	23.11	3.99	1.20	0.93	0.09	0.03	33.27	11.25	3.39
Females																
6	12	26.67	3.94	1.14	121.6	4.48	1.29	17.95	1.88	0.54	0.88	0.04	0.01	18.72	2.78	0.80
7	11	33.95	4.19	1.26	128.9	2.65	0.80	20.39	1.97	0.60	0.88	0.06	0.02	20.30	5.85	1.76
8	13	36.81	6.87	1.90	132.0	4.14	1.15	20.98	2.82	0.78	0.88	0.05	0.01	23.59	7.91	2.19
9	12	40.88	8.63	2.49	136.1	3.91	1.13	21.98	3.59	1.04	0.91	0.05	0.01	27.61	9.04	2.61
10	11	43.55	7.67	2.31	140.1	4.58	1.38	22.07	2.96	0.89	0.95	0.02	0.01	28.55	7.16	2.16
11	12	46.79	7.75	2.24	143.9	7.23	2.09	22.46	2.09	0.60	0.94	0.03	0.01	29.33	10.64	3.07
12	12	51.08	6.68	1.93	150.5	4.52	1.30	22.49	2.25	0.65	0.93	0.02	0.01	32.28	9.70	2.80
13	12	57.00	8.88	2.56	155.5	5.98	1.72	23.45	2.45	0.71	0.93	0.04	0.01	34.61	8.28	2.39
p- values		***0.18***			***0.92***			***0.004***			***0.02***			***0.003***		

6.2.2 Comparison of findings of weight and height values to reference normative data

Pooled, average weight and height values for the different ages (6 to 13 years) were plotted against the reference percentile curves of NHANES data, the results of which are summarised in Figures 6.1 and 6.2, respectively. For both genders between the ages 6 and 8 years, weight values are at or above the 95th percentile curve, but a decline is observed from age 9 and begins to follow similar pattern to the 90th percentile curve for boys, and turn down to be just above 75th percentile curve for girls of USA children of similar ages (Figures 6.1). Height values, on the other hand, show males at the age of 6 years reported similar height values of 95th percentile curve of NHANES and 90th percentile curve in ages 6 and 7 years for females. The curve then tended to slow up to the age of 13 year to pursue a model between 50th and 75th reference percentile curves of NHANES for boys, and follow a pattern beside the 50th percentile curve for females (Figure 6.2).

Averaging median curves would be a simple way to summarise the age trend in body mass index (BMI) through childhood but the resulting position of the curve at each age would depend on the prevalence of overweight, and would be comparatively arbitrary. In any case, the median is not an extreme centile and is ineffective as a cut off point. Instead, Cole *et al.* (2000) have developed centile curves linked to adult cut off points of 25 kg/m^2 (50th centile) and 30 kg/m^2 (90th centile) have been devised and positioned at age 18 years to maximise the available data sets. Previously, Magbool (1994) had reported BMI centiles for 6 to 16 year old Saudi school children based on data from 21,638 children in the Eastern Province, which borders Kuwait. Weights and heights of the study population were measured and their BMI calculated. Pooled, average BMI values for the different ages were plotted against the reference curves of Cole *et al.* (2000) and Magbool's centile data from Saudi Arabia the results of which are summarised in Figures 6.3 and 6.4, respectively.



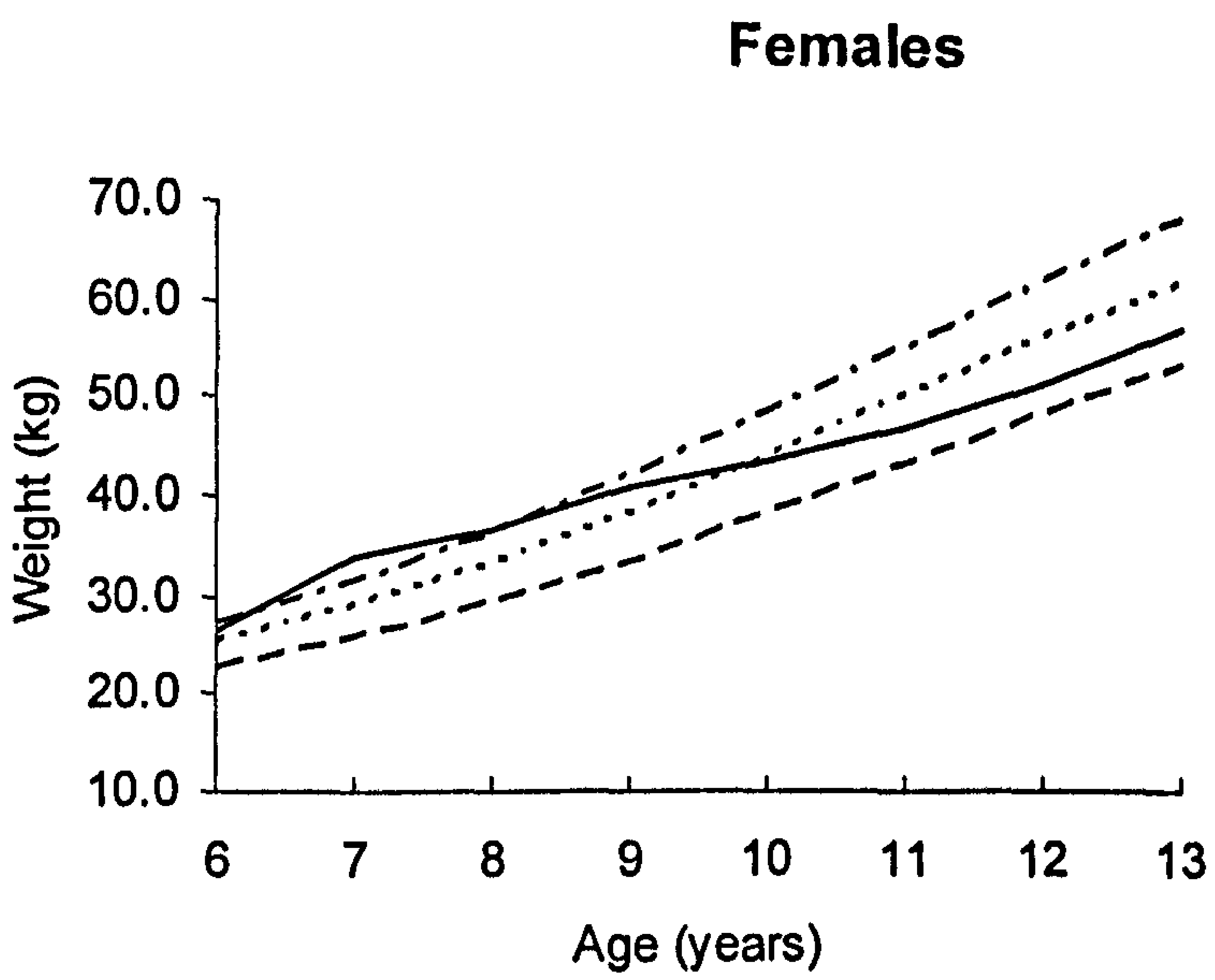
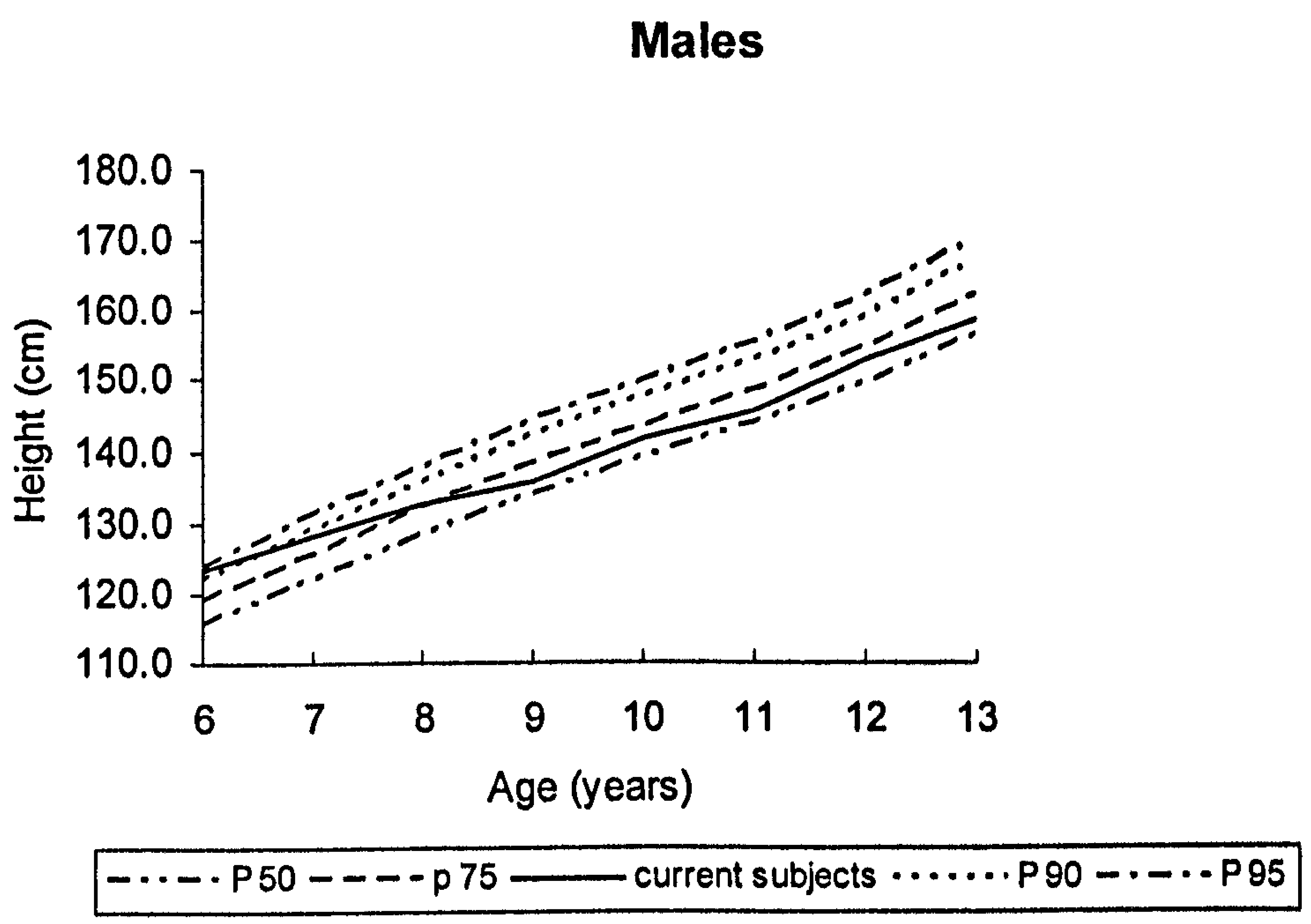


Figure 6.1 Shows the comparison between pooled mean weight values of 6 – 13 year old Kuwaiti school children and percentile curves of USA 2000 CDC growth charts data.



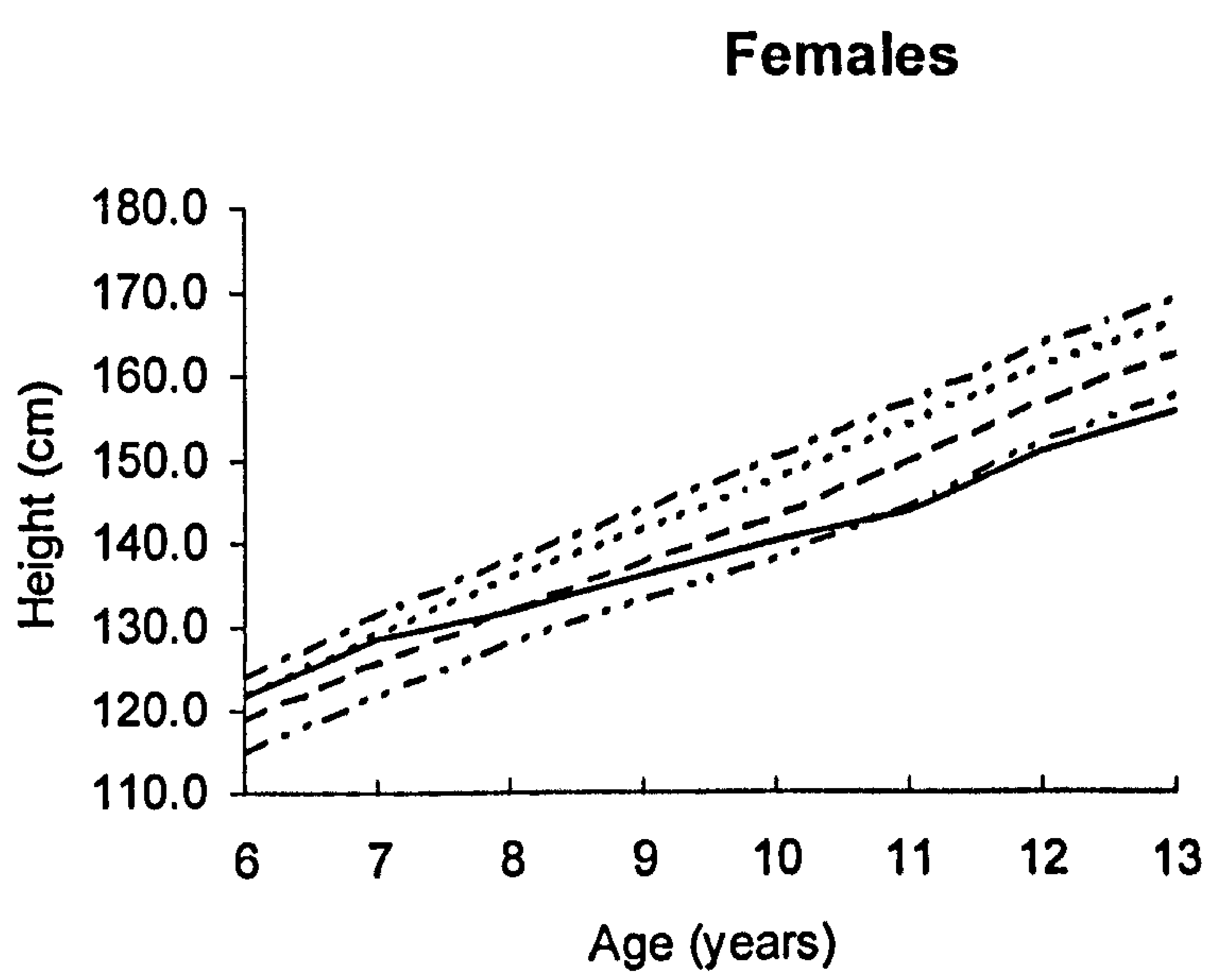


Figure 6.2 Shows the comparison between pooled mean height values of 6 – 13 year old Kuwaiti school children and percentile curves of USA 2000 CDC growth charts data.

The results show that compared to the Cole *et al.* (2000) reference curves, both boys and girls aged 6 to 13 years (both primary and intermediate school ages) in this study population were between 25 kg/m^2 (50th centile) and 30 kg/m^2 (90th centile) curves, with area of little variation, throughout except in the case of boys at age 6 years when the BMI curve is to some extent under the 25 kg/m^2 (50th centile) curve of similar ages (Figure 6.3). Compared to the Saudi reference (Magbool) curves however, both genders between the ages of 6 and 10 years (i.e. primary school children) have BMI values above to the 90th centile curve, with plateaus in the BMI from ages 11 to 13 years (i.e. intermediate school children). While boys from ages 11 to 13 years follow a pattern along the 90th centile curve of Saudi children of similar ages, BMI values for girls are slightly below to the 90th centile curve (Figure 6.4).

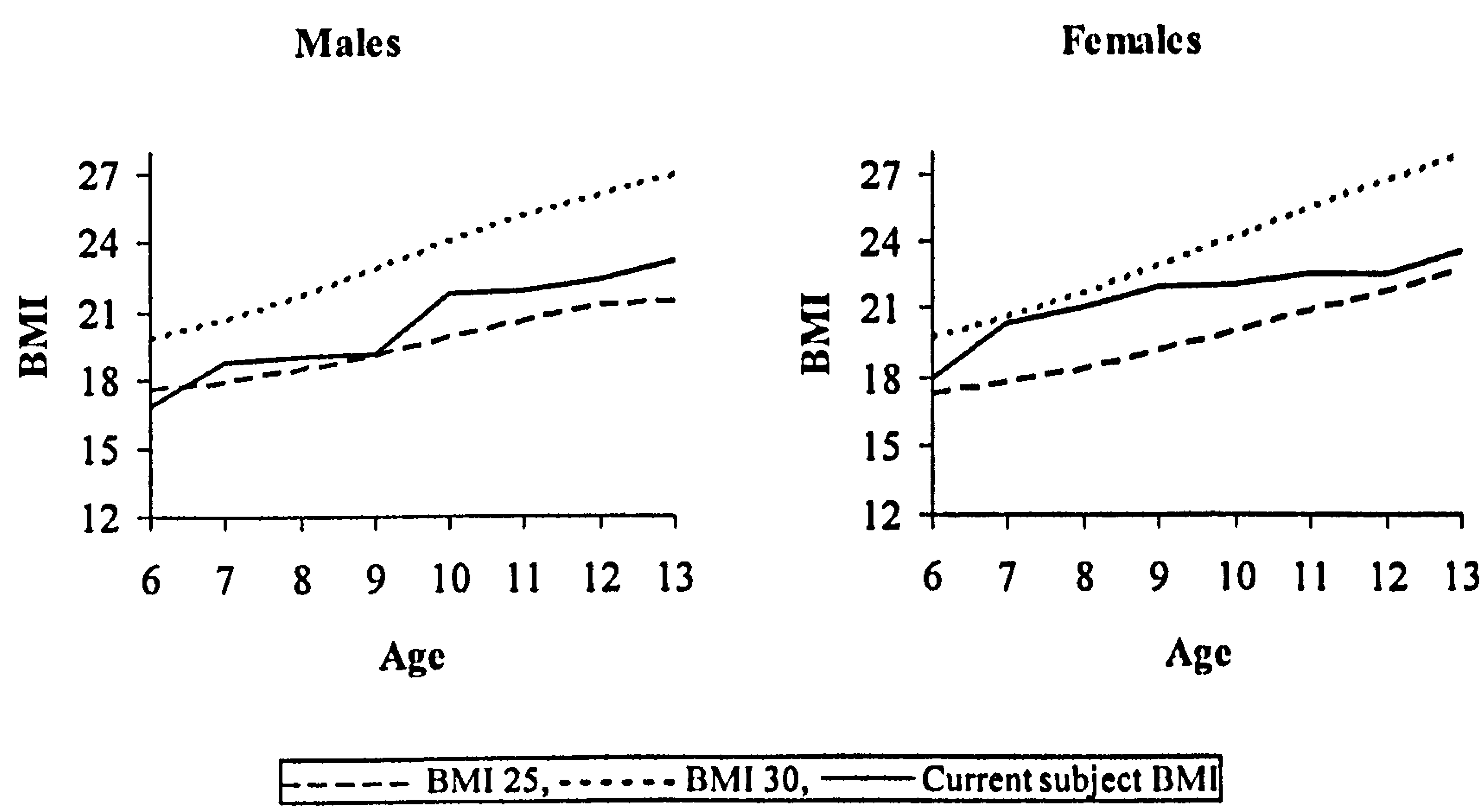


Figure 6.3 Shows the comparison between pooled mean Body Mass Index (BMI) values of 6-13 year old Kuwaiti school children and international reference curves from Cole *et al.* (2000).

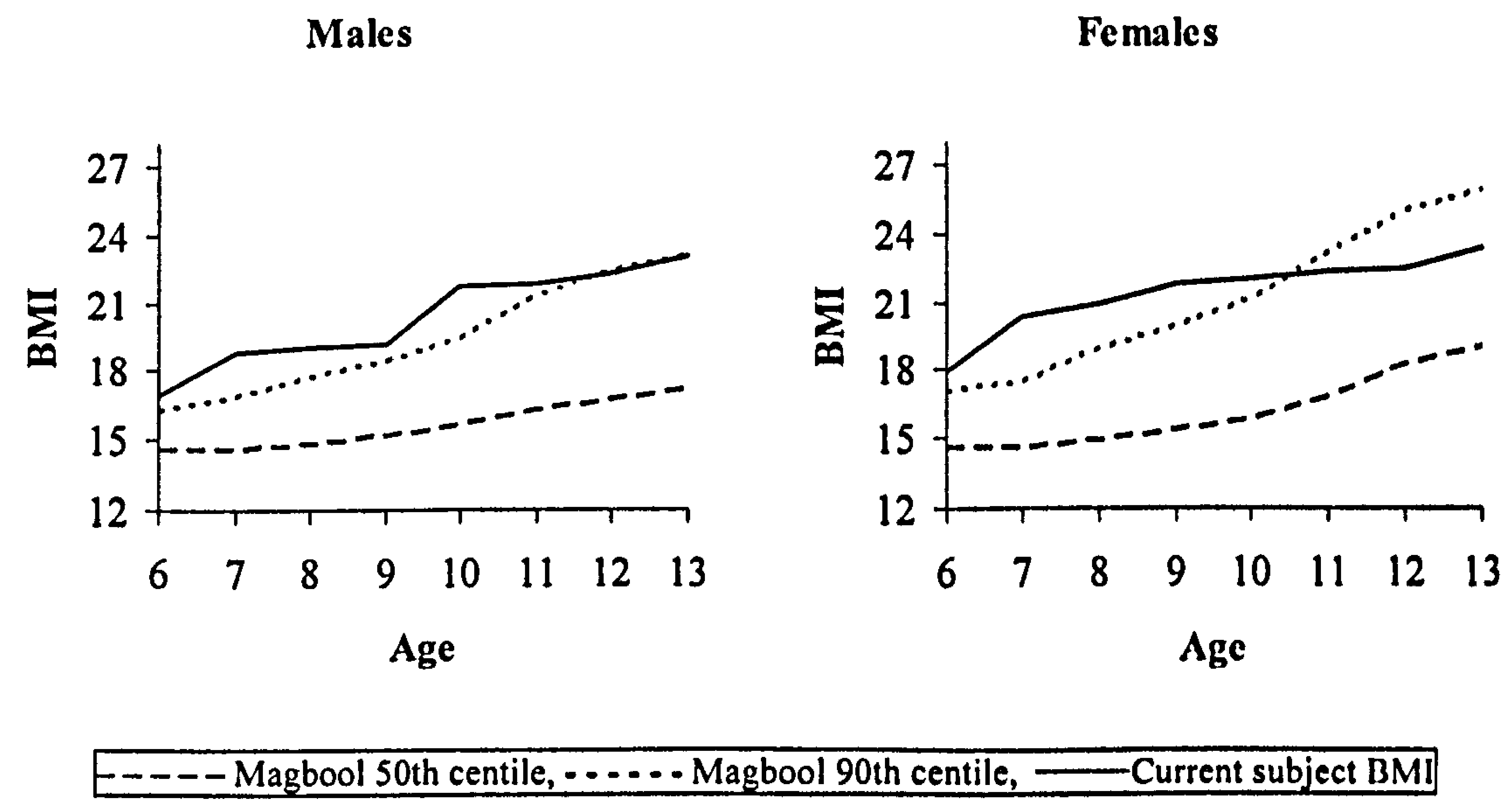


Figure 6.4 Shows the comparison between pooled mean BMI values (kg/m^2) of 6 – 13 year old Kuwaiti school children and Regional values from Eastern Province of Saudi Arabia of Magbool (1994) data.

According to CDC Growth charts, children had a BMI-for age ≥ 85th percentile and < 95th percentile are categorised as "at risk of overweight" (overweight person). A BMI-for age ≥ 95th percentile is categorised as "overweight" (obese person). Pooled average BMI values were also plotted against the American reference percentile curves of NHANES data, the results of which are illustrated in Figure 6.5 shows that boys aged 6 to 10 years follow a zigzag curve pattern around the 90th percentile values and comparable for 11 to 13 years old. Girls, on the other hand, aged 6 years old have BMI values more than the 90th percentile curve with a raise from 7 to 9 years above the 95th percentile curve, and a decrease from age 10 years and follow a pattern slightly above the 85th percentile curve of NHANES.

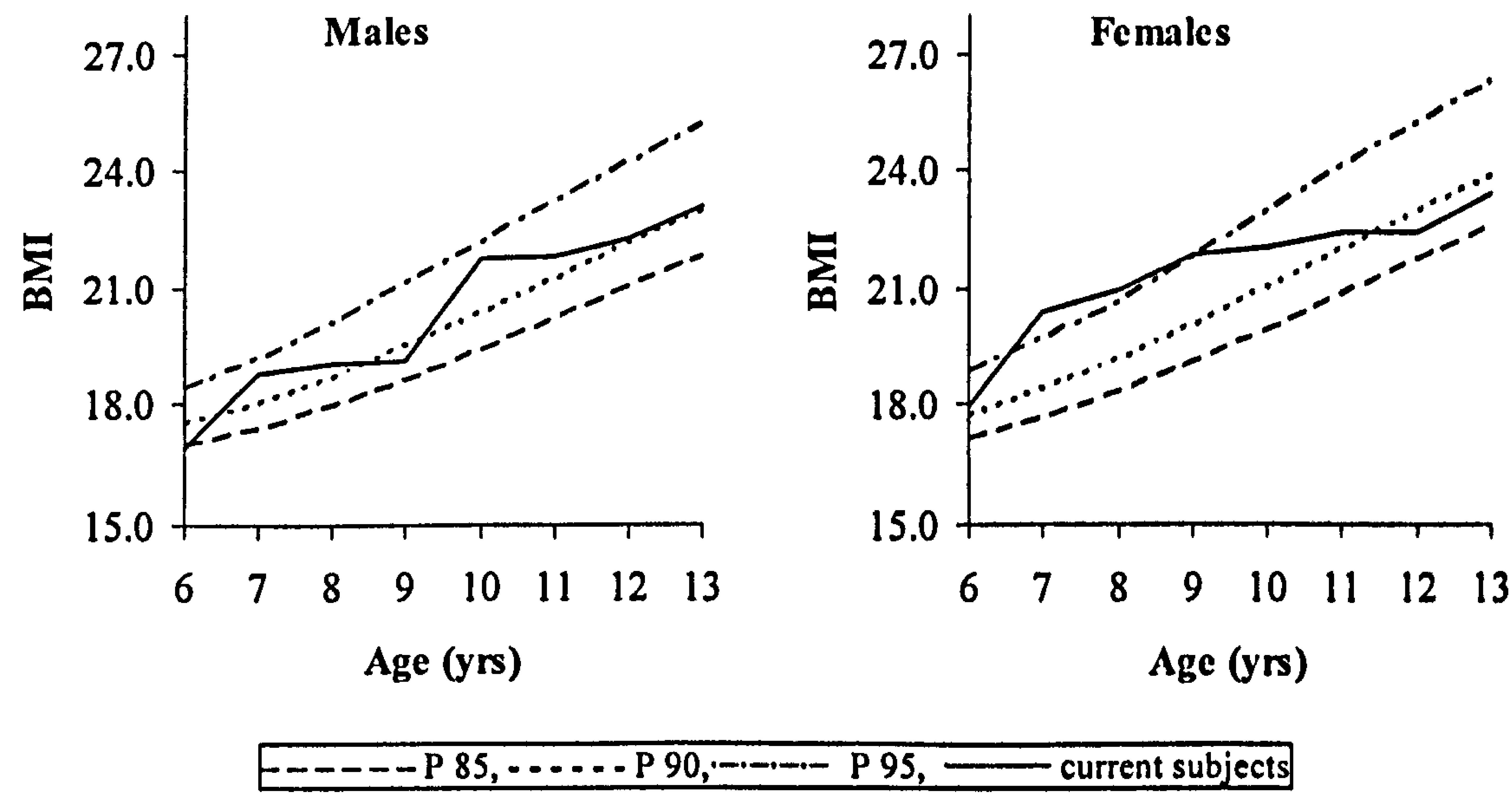


Figure 6.5 Shows the comparison between pooled mean BMI values (kg/m^2) of 6 – 13 year old Kuwaiti school children and reference percentile curves of NHANES data.

Table 6.2 presents the percentages of weight, height and BMI values relative to the NCHS reference values (50th percentile, see the NCHS – 2000 CDC Growth Charts Website) for each age and sex stratum. The derived values for both populations showed that the relative weight for age (R-WFA) reported were the greater variable than the other, while relative height for age (R-HFA) is the smallest one. R-WFA varied from 124% to 137% and from 122% to 148%, for males and females, respectively. The percentage height of Kuwaiti school children showed a maximum value at the age of 6 years (106%) for both boys and girls, while minimum in 11 years old boys (101%) and 13 year old girls (99%). Relative BMI for age (R-BMIFA) results showed that the smallest values were about 110% and 118% boys and girls, 6 years of age respectively. However, highest R-BMIFA was noticed age 10 years (130%) for boys and 9 years (134%) for girls.

Table 6.2 Shows relative weight for age (R-WFA), relative height for age (R-HFA) and relative BMI for age (R-BMIFA)

Age (yrs) & Sex	Weight (kg)	R-WFA (%)	Height (cm)	R-HFA (%)	BMI (kg/m²)	R-BMIFA (%)
Males						
6	25.88	124.58	123.59	106.55	16.91	109.92
7	30.92	133.46	127.96	104.89	18.80	121.19
8	33.57	130.37	132.64	103.63	19.03	120.59
9	35.42	123.49	135.71	101.27	19.14	118.39
10	44.00	137.11	141.54	101.83	21.76	130.70
11	46.40	128.64	145.40	100.97	21.84	127.00
12	52.45	128.98	152.86	102.59	22.28	125.12
13	58.82	128.40	158.59	101.66	23.11	125.15
Average	40.93	129.38	139.79	102.92	20.36	122.26
Females						
6	26.67	131.10	121.63	105.76	17.95	117.97
7	33.95	148.47	128.91	105.66	20.39	131.96
8	36.81	142.89	132.00	103.13	20.98	132.54
9	40.88	140.27	136.08	102.32	21.89	134.22
10	43.55	131.72	140.09	101.52	22.07	130.88
11	46.79	125.14	143.88	99.91	22.46	128.55
12	51.08	122.12	150.54	99.70	22.49	124.24
13	57.00	123.97	155.54	99.07	23.45	125.14
Average	42.09	133.21	138.58	102.13	21.46	128.19

R-WFA = (current weight (kg) / NCHS reference values (50th percentile)) × 100
R-HFA = (current height (cm) / NCHS reference values (50th percentile)) × 100
R-BMIFA = (current BMI / NCHS reference values (50th percentile)) × 100

6.2.3 BMI Cut-off points and Z-scores

The z-score provides a meaningful way of comparing scores from different distributions that have different means and standard deviations. It helps to standardise growth data for purposes of objective comparison. The BMI z-scores calculated in this study show a consistent upward trend relative to NCHS (2000) reference data and regional (local) data based on Magbool (1994), see Table 6.3. In both cases, the z-scores lie between 1.0 and 2.0 for boys and 1.5 and 3.0 for girls aged 6 to 13 years although the figures relative to the Magbool reference are higher than NCHS comparisons (Figure 6.6). In particular, BMI z-scores for females at ages 7 and 11 years were in the region of 3.0, indicating that these two ages were associated with a high BMI in this population. Interestingly, the z-scores showed a gentle downward slope from age 8 till 10 years; then began to rise again till age 11years and fell again afterwards.

In this study, an attempt was made to see if the z-scores matched the observed high BMI percentiles (between 85th and 95th percentiles across the age groups with reference to the normative values of NCHS (2000), and Magbool (1994)). It appears in this case that the traditional ±2.0 cut-off points for z-score used in assessing growth in children if applied here, would under-estimate the prevalence of overweight and obesity and therefore under-estimate any possible risk of associated co-morbidities in this population.

Table 6.3 Shows the mean and 95% confidence intervals (CI) of BMI-for-age Z-scores of Kuwaiti school children aged 6 – 13 year (n =194; 99 boys and 95 girls) by age and sex

Age & Sex	BMI-Current Study	Z-score: Mean (95% CI)	
	Mean (± SEM)	(NCHS, 2000, USA)	(Magbool, 1994)
Male			
6	16.91 (± 0.37)	1.017 (0.484, 1.550)	1.531 (0.998, 2.064)
7	18.80 (± 0.60)	1.524 (0.920, 2.128)	1.938 (1.334, 2.542)
8	19.03 (± 0.60)	1.456 (0.878, 2.034)	1.892 (1.314, 2.470)
9	19.14 (± 0.80)	1.085 (0.449, 1.721)	1.458 (0.822, 1.458)
10	21.76 (± 1.19)	1.250 (0.614, 1.886)	1.494 (0.858, 2.130)
11	21.84 (± 1.34)	1.103 (0.388, 1.818)	1.329 (0.614, 2.044)
12	22.28 (± 1.01)	1.346 (0.674, 2.018)	1.681 (1.009, 2.353)
13	23.11 (± 1.20)	1.171 (0.499, 1.843)	1.503 (0.831, 2.175)
Female			
6	17.95 (± 0.54)	1.460 (0.826, 2.094)	1.779 (1.145, 2.413)
7	20.39 (± 0.60)	2.511 (1.838, 3.184)	2.953 (2.280, 3.626)
8	20.98 (± 0.78)	1.833 (1.228, 2.438)	2.163 (1.558, 2.768)
9	21.89 (± 1.04)	1.562 (0.926, 2.198)	1.819 (1.183, 2.455)
10	22.07 (± 0.89)	1.766 (1.094, 2.437)	1.920 (1.249, 2.591)
11	22.46 (± 0.60)	2.399 (1.764, 3.034)	2.692 (2.057, 3.327)
12	22.49 (± 0.65)	1.935 (1.307, 2.563)	1.878 (1.250, 2.506)
13	23.45 (± 0.71)	1.967 (1.322, 2.612)	1.780 (1.135, 2.425)

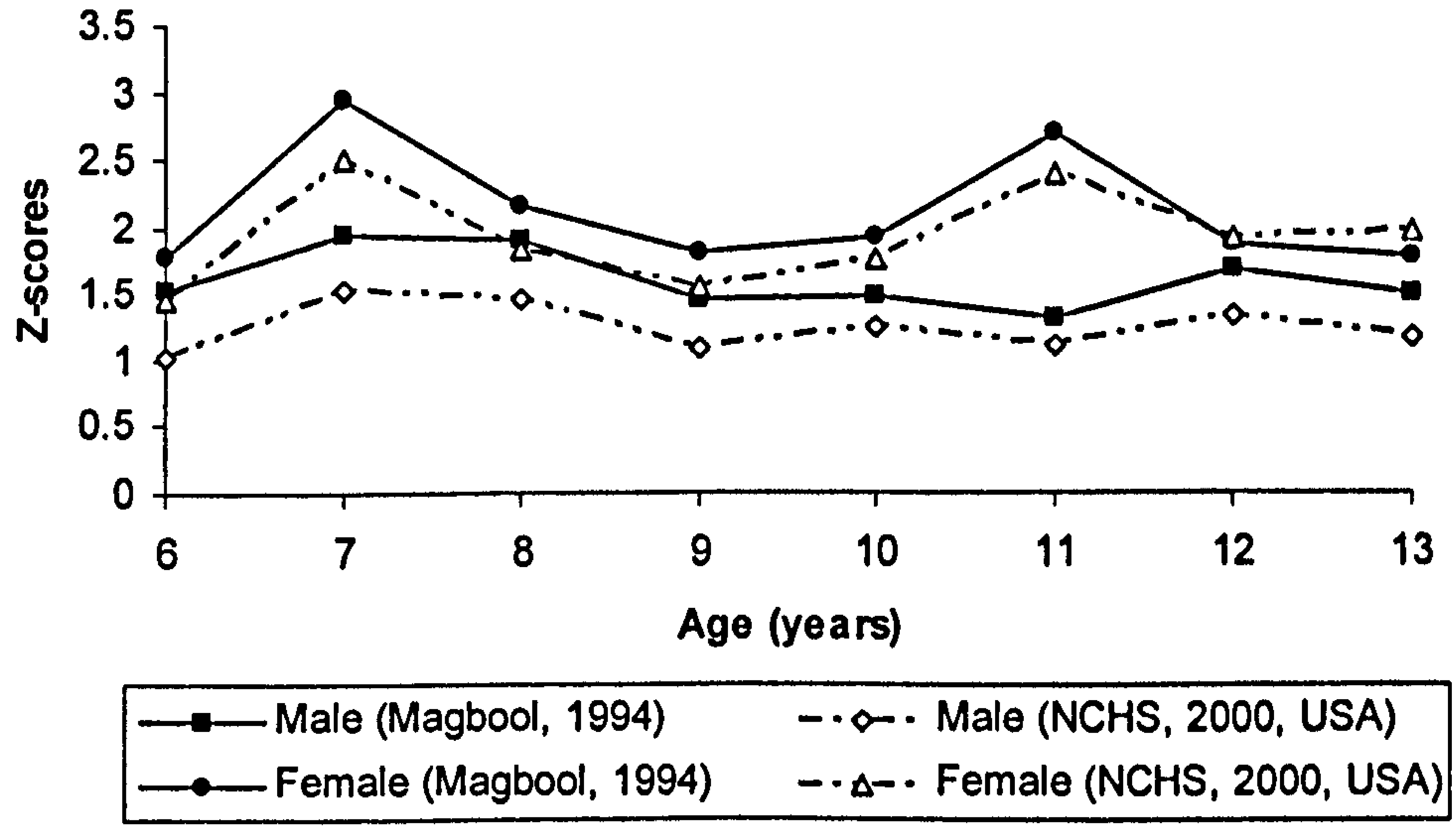


Figure 6.6 BMI z-scores of male and female Kuwaiti school children aged 6 – 13 years (total 194 subjects) relative to NCHS (2000) reference data and regional (local) data based on Magbool (1994).

6.2.4 Trends in Weight, Height, and BMI of Kuwaiti school children over time

Eid *et al.* (1986) had reported the weight (W) and height (H) for 6 to 17 year old Kuwaiti school children during the academic year 1983/1984, which was two decades ago. The present Kuwaiti school children are heavier and taller than those reported in Eid *et al.* (1986) study (Figure 6.7). As shown in the figure below, both weight and height values have shifted over the last two decades among Kuwaiti school children 6 to 13 year olds. There is a consistent upward trend in weight and height in boys and girls in this genetically homogenous population, and hence body mass index. These very important trends will be discussed further in the discussion section.

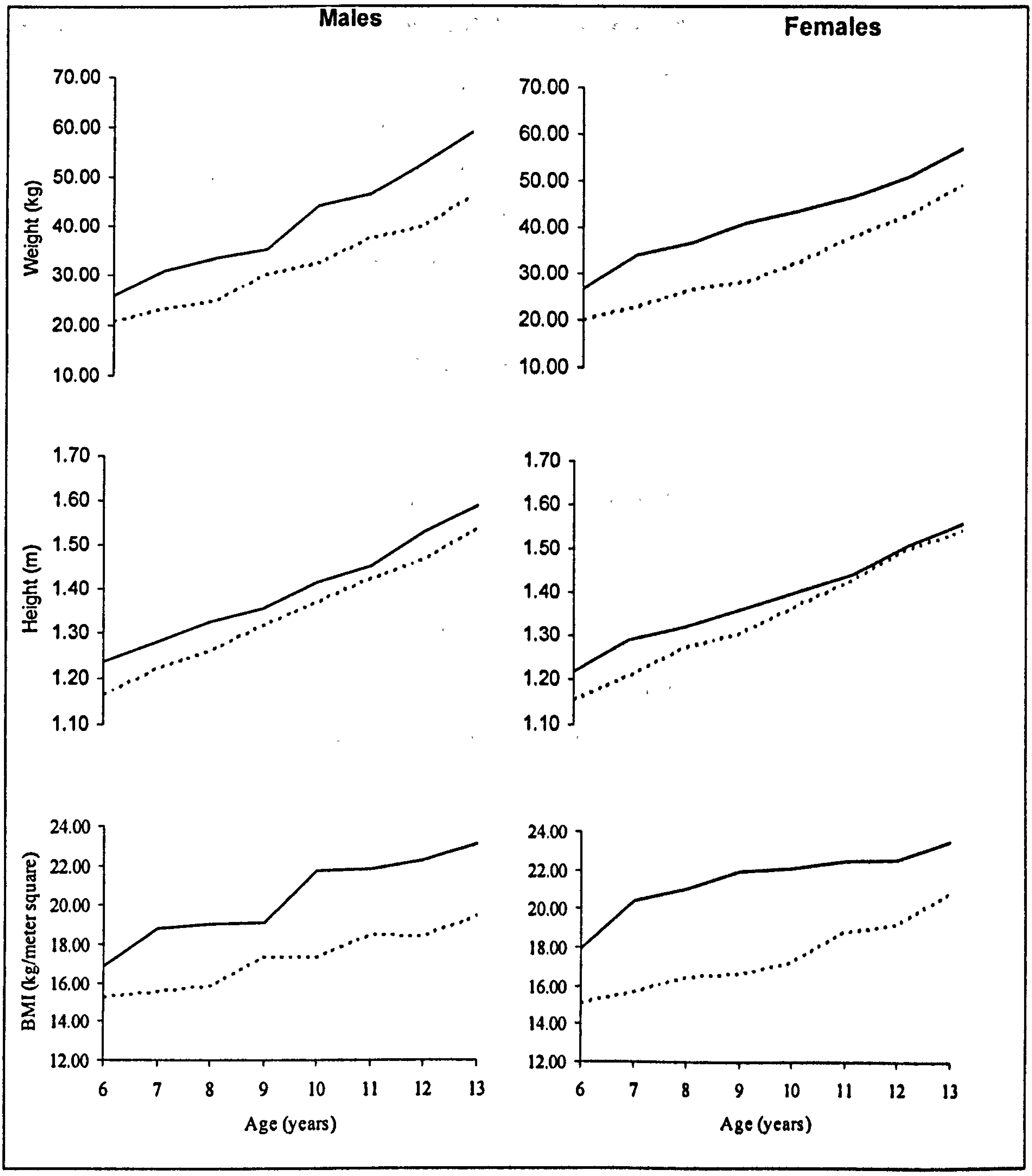


Figure 6.7 Comparison of Mean weight, height, and BMI of Kuwaiti school children in current study (———) with a similar age and sex-matched cohort (Eid *et al.*, 1986) twenty years earlier (.........).

6.2.5 Girth measurements and body fat distribution from skinfold thickness

The highest WHR values for boys and girls were reported in ages 12 years (0.94) and 10 years (0.95), respectively, see Table 6.1. Previously, Moussa *et al.* (1999) had determined WHR mean values (± SD) for 6 to 13 year old Kuwaiti school children based on data from 460 obese and 460 non-obese children in Kuwait. The Pooled, average WHR values ± SD for the different ages and genders were plotted against the values of Moussa *et al.*, (1999) and the results are summarised in Figure 6.8 below. The results show an upward shift in WHR in the current study although the differences recorded are not statistically significant.

The sum of triceps and subscapular skinfold thickness (TSF + SSSF) for each age group of Kuwaiti school children were compared with the reference percentiles of Frisancho (Frisancho, 1990). Figure 6.9 shows that both boys and girls curves are in the region of following the way above 75th and below 85th percentile values of Frisancho, i.e. school children skinfold thickness ≥ 75th percentile and < 85th percentile, except for values for boys of ages 12 and 13 who recorded values ≥ 85th percentile. Between ages 7 and 9 years, boys in the current study seem to slow down (dip) and then follow the curve pattern of 75th percentile. The rise of SFT values in boys starts from age 10 to 12 years where they begin to exceed the 85th percentile at age 13 years. In contrast, girls' SFT is almost comparable to the 75th percentile curve.

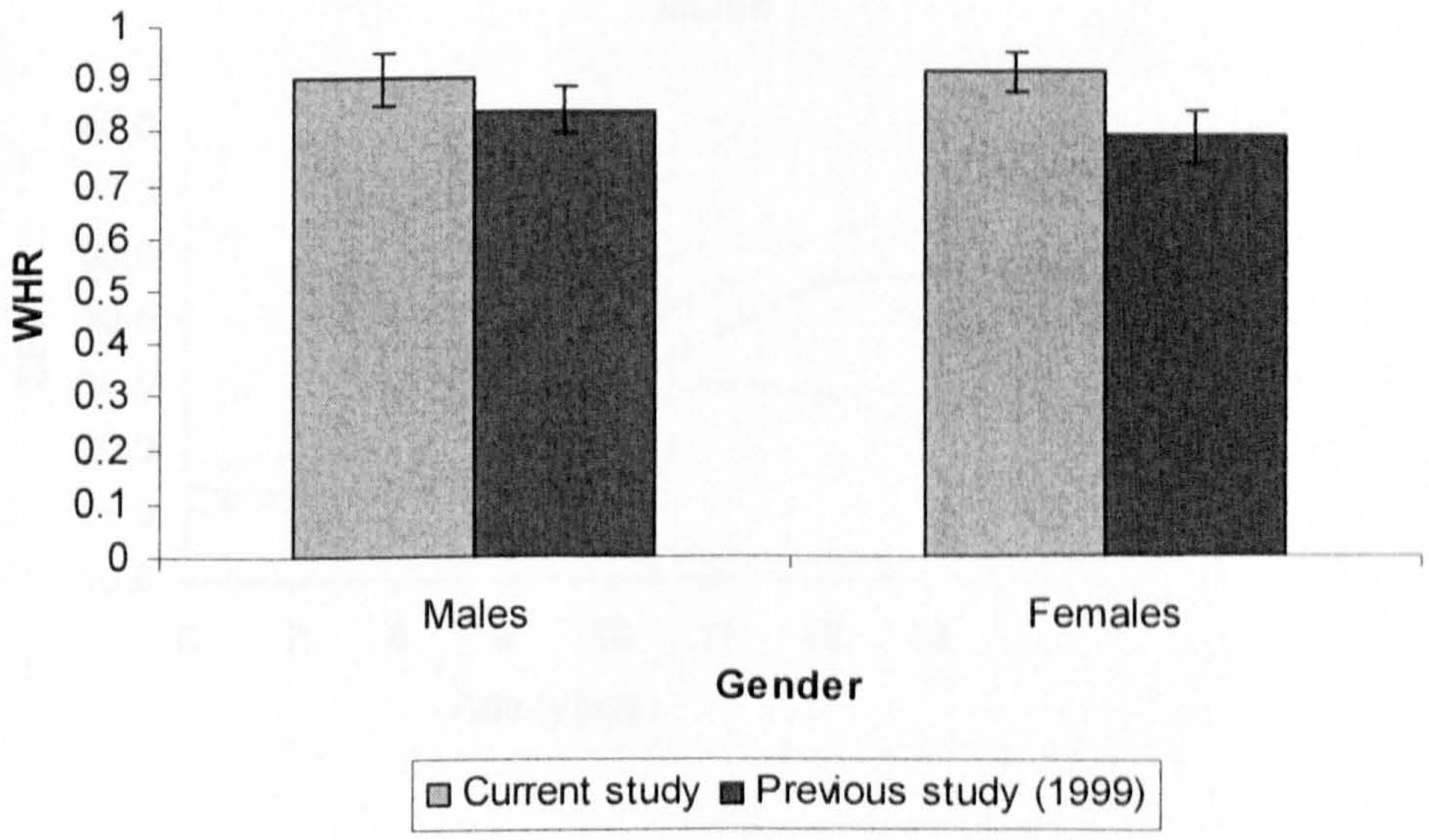


Figure 6.8 Waist-to-hip ratio (WHR) mean values ± standard deviation error (SD) for current subjects (99 boys and 95 girls) of ages 6 – 13 years, compared with Kuwaiti school children in Moussa *et al.* (1999) study for comparable age group.

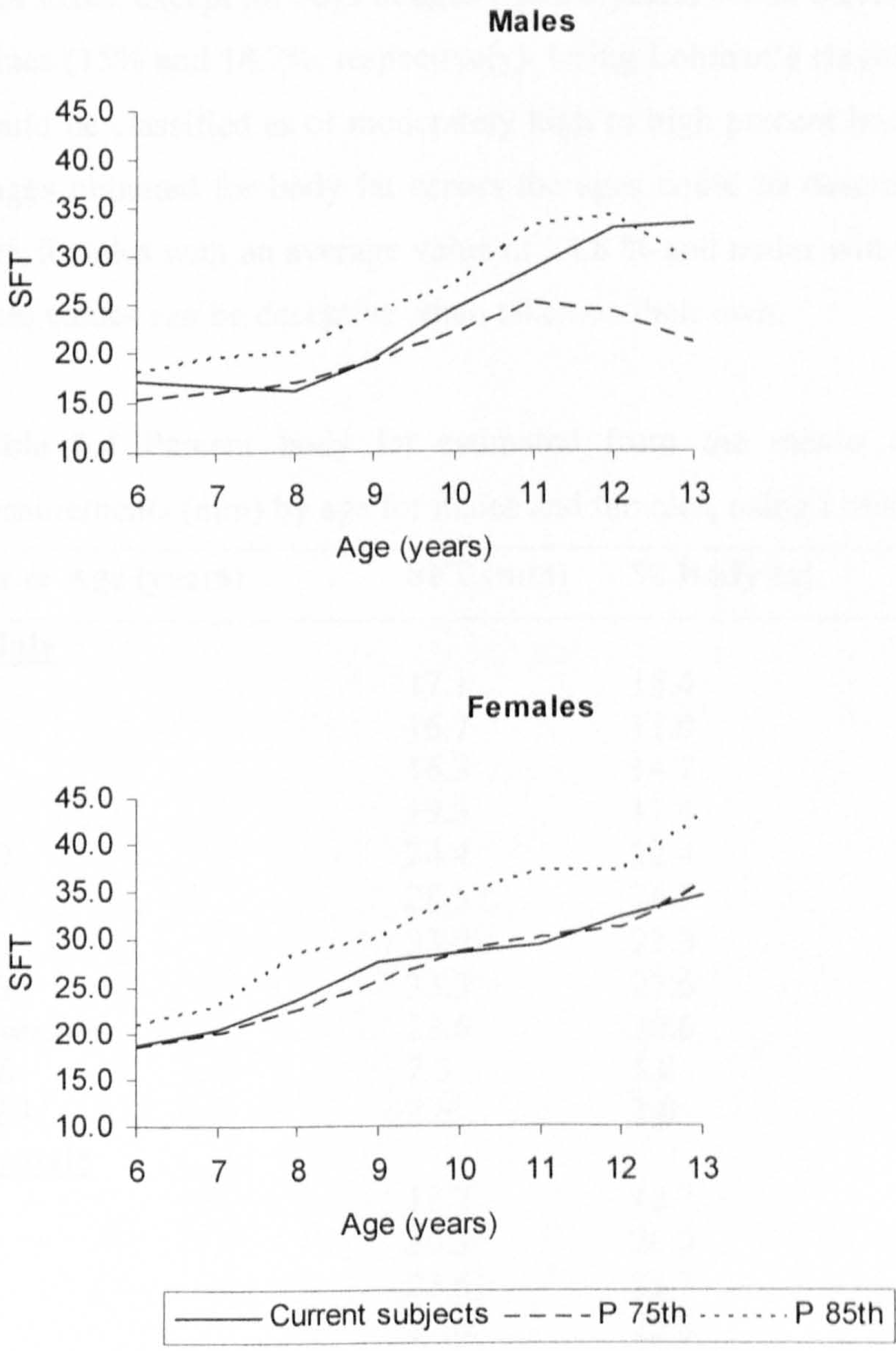


Figure 6.9 Shows the comparison between pooled mean of sum skinfold thickness in millimetres (triceps and subscapular skinfolds) values of 6 to 13 year old school children (99 males and 95 females) in Kuwait and percentiles of Frisancho (1990) study, (75th and 85th percentile).

The sum of triceps and subscapular skinfolds were measured and used to estimate percent body fat as previously outlined by Lohman, (1987) for persons 6 to 17 years old based on the sum of triceps and subscapular skinfold measurement. Using the Lohman (1987) equations, percent body fat of subjects were estimated based on the mean of skinfold thickness (SFT), (Table 6.4). Mean percent body fat increased with age in this study for both sexes, except for boys of ages 7 and 8 years, which decreased and reported the lowest values (15% and 14.7%, respectively). Using Lohman's classification, 10 to 13 years olds would be classified as of moderately high to high percent body fat. Overall however, the ranges obtained for body fat across the ages could be described as moderately high i.e. with females with an average value of 24.8 % and males with 20.6 % body fat. However, these values can be deceptive when taken on their own.

Table 6.4 Percent body fat estimated from the means of sum skinfold thickness measurements (mm) by age for males and females, using Lohman standards

Sex & Age (years)	SFT (mm)	% Body fat	Classification
<u>Male</u>			
6	17.1	15.4	optimal
7	16.7	15.0	optimal
8	16.3	14.7	optimal
9	19.3	17.4	optimal
10	24.4	22.4	moderately high
11	28.5	24.7	moderately high
12	33.0	27.3	high
13	33.3	27.6	high
Average	23.6	20.6	moderately high
SD	7.3	5.8	
SEM	2.6	2.0	
<u>Female</u>			
6	18.7	18.7	optimal
7	20.3	20.3	optimal
8	23.6	22.7	optimal
9	27.6	25.8	moderately high
10	28.5	26.6	moderately high
11	29.3	27.3	moderately high
12	32.3	27.7	moderately high
13	34.6	29.6	moderately high
Average	26.9	24.8	moderately high
SD	5.6	3.8	
SEM	2.0	1.4	

6.2.6 Prevalence of overweight and obesity by BMI and SFT

The study population of Kuwaiti school children of this chapter (194 subjects) was classified into two age groups, 6 – 9 years and 10 – 13 years. Fifty five boys and forty eight girls in age group 6 – 9 years, whereas 10 – 13 year old included 44 males and 47 females (Table 6.5).

Table 6.5 Classification of 194 Kuwaiti school children for the present study based on age and sex

Age groups	Males	Females	Total
6-9 years	55	48	103
10-13 years	44	47	91
Total	99	95	194

Since BMI varies with age; a given value of BMI was evaluated against each age and gender specific reference values. The prevalence of overweight and obesity among Kuwaiti children aged 6 – 9 years and 10 – 13 year for the two different genders is given in Table 6.6, based on BMI cut-off points of Cole *et al.* (2000) and CDC (2000) references. Over 53% of overall boys (53 of 99 subjects) were considered to be either overweight or obese, used Cole *et al.* (2000) cut-off points, with about one-third of them falling into the obesity category. Prevalence of overweight among female subjects was found to be 50.5% (48 of 95 subjects), and 21.1% were found to be clinically obese.

The percentage prevalence of overweight and obesity using the international criteria based on Cole *et al.* (2000) for males and females are shown by Figure 6.10. Of those classified as obese, 16.4% are boys and 35.4% are girls reported in the age-group 6 – 9 years compared with 13.6% and 6.4% of girls in the 10 – 13 year age category.

On the other hand, when using CDC reference population cut-off points, the results showed that overall, 29.3% (N=29) of boys were overweight (BMI-for-age ≥ 85^{th} percentile to < 95^{th} percentile) and 28.3% (N=28) were obese (BMI-for-age ≥ 95^{th} percentile). In female subjects, both overweight and obese groups were of a similar magnitude (36% each) thus suggesting that the prevalence of overweight and obesity was much higher in girls than boys. This pattern is not dissimilar to observations elsewhere in the Arab Gulf region and in European and American studies.

Overall, the total results of this study show that using the CDC cut-offs for the definition of overweight and obesity, 57.6% and 72.6% of boys and girls respectively were either overweight or obese (Figure 6.11). Over 29% (16) of male subjects and 54% (26) of female subjects in the 6 – 9 year group will be categorized as obese whereas 27% (12) of males and 17% (8) of females in the 10 – 13 year group will be classified as obese.

Table 6.6 Number (N) and percentage (%) of overweight and obese subjects among 194 Kuwaiti school-age children (99 males and 95 females) of two age groups (6-9 years and10-13 year) for two different genders based on BMI cut-off points of Cole *et al.* (2000) and CDC (2000) references

	Males						Females					
	6-9 years		10-13 year		Total		6-9 years		10-13 year		Total	
Overweight and obesity categories	N	%	N	%	N	%	N	%	N	%	N	%
Cole *et al* (2000)												
≥ 25 to < 30 kg/m^2	18	32.7	20	45.5	38	38.4	17	35.4	31	66.0	48	50.5
≥ 30 kg/m^2	9	16.4	6	13.6	15	15.2	17	35.4	3	6.4	20	21.1
Total	27	49.1	26	59.1	53	53.5	34	70.8	34	72.3	68	71.6
CDC (2000)												
≥ 85th percentile to < 95th percentile	14	25.5	15	34.1	29	29.3	9	18.8	26	55.3	35	36.8
≥ 95th percentile	16	29.1	12	27.3	28	28.3	26	54.2	8	17.0	34	35.8
Total	30	54.6	27	61.4	57	57.6	35	72.9	34	72.3	69	72.6

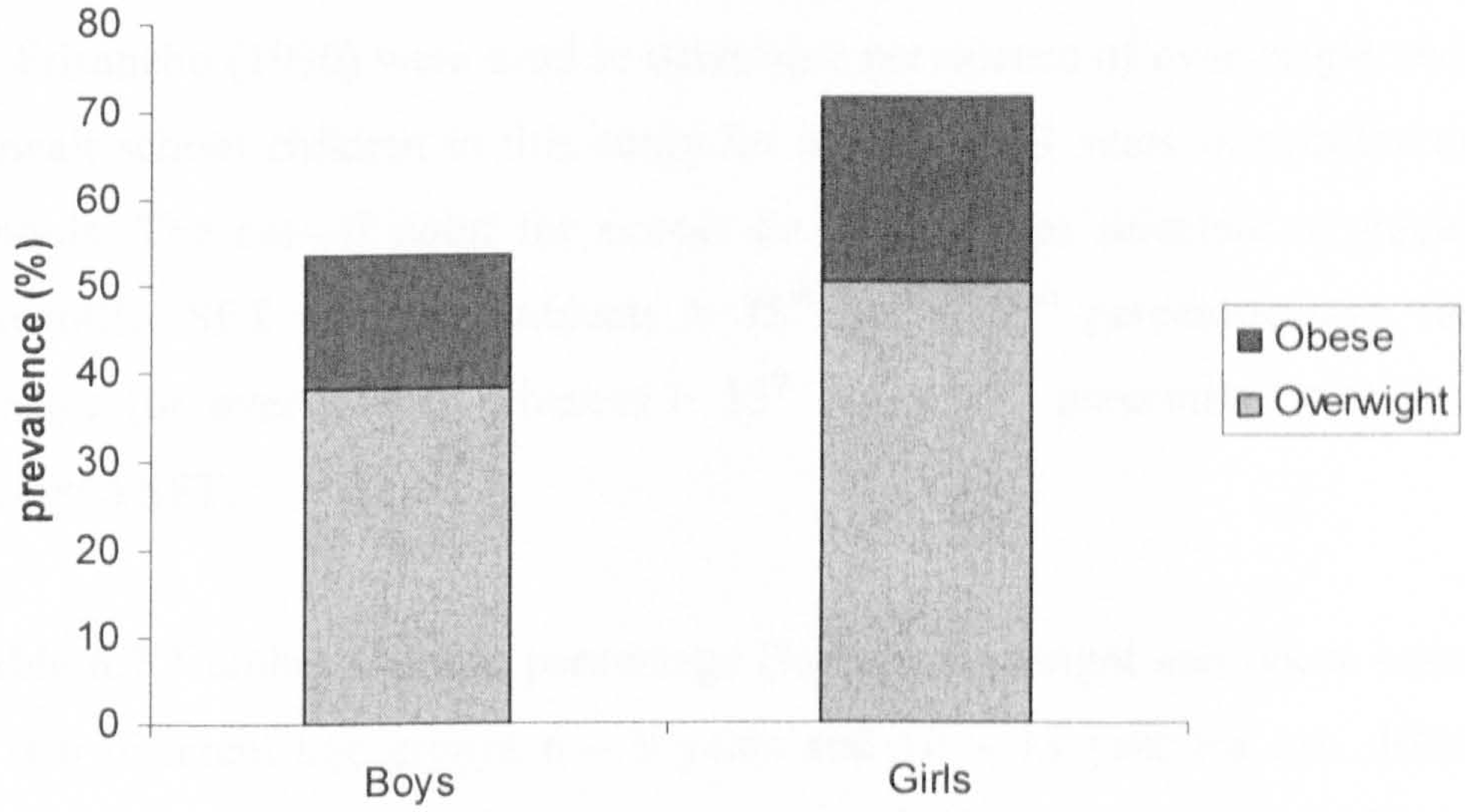


Fig. 6.10 Prevalence of overweight and obesity among 194 school-age children (6 – 13 years) in Kuwait for two different genders. Overweight and obesity based on BMI cut-off points of Cole *et al.* (2000) reference population.

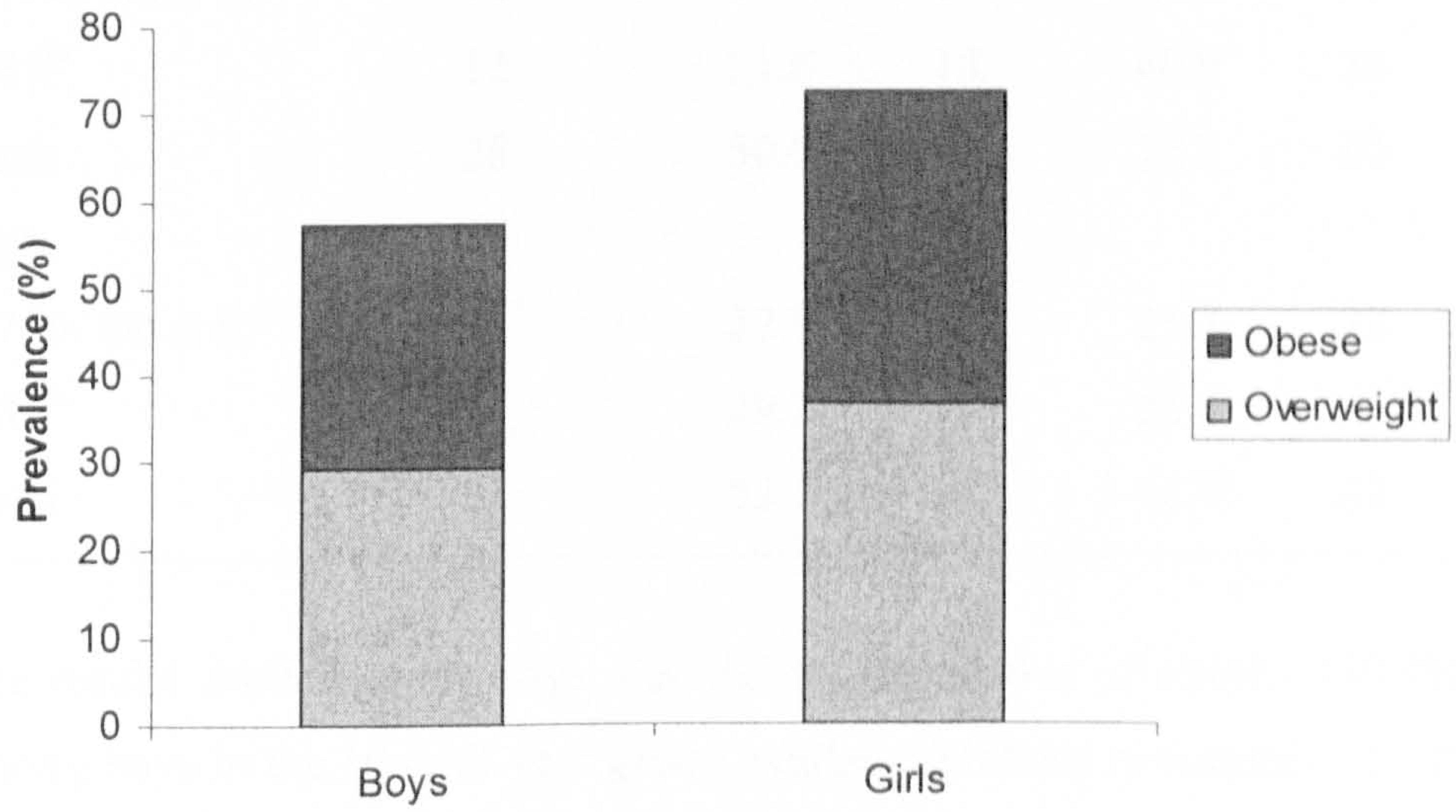


Figure 6.11 Prevalence of overweight and obesity among 194 school-age children (6 – 13 years) in Kuwait for two different genders. Overweight and obesity based on BMI cut-off points of CDC (2000) reference population.

The prevalence of obesity and overweight by using sum of triceps and subscapular skinfold thickness (SFT) is given in Table 6.7. The cut-off points (percentiles) suggested by Frisancho (1990) were used to determine prevalence of overweight and obesity among Kuwait school children in this study for ages 6 to 13 years in primary and intermediate schools. The cut-off point for excess fat (obese) was selected as greater than the 85^{th} percentile. SFT value of subjects > 75^{th} but ≤ 85^{th} percentile was considered above average (or overweight), whereas > 15^{th} but ≤ 75^{th} percentile (average) for normal or accepted SFT.

Table 6.7 Number (N) and percentage (%) of overweight and obese school-age children in two different age groups 6 – 9 years and 10 – 13 year for two different genders in Kuwait based on sum of triceps and subscapular skinfold thickness (SFT) cut-off points of Frisancho (1990) reference

	6- 9 years		10- 13 years		Total	
Obesity category	N	%	N	%	N	%
Boys						
> 75th but ≤ 85^{th}	16	29.1	14	31.8	30	30.3
> 85^{th}	12	21.8	18	40.9	30	30.3
Total	28	50.9	32	72.7	60	60.6
Girls						
> 75th but ≤ 85^{th}	11	22.9	12	25.5	23	24.2
> 85^{th}	14	29.2	11	23.4	25	26.3
Total	25	52.1	23	48.9	48	50.5

The results show that for boys, the highest prevalence of obesity (40.9%) was reported among boys in the 10 – 13 year group, whilst the lowest prevalence (21.8%) was in the 6 – 9 years age group. Among girls overall, 24.2% (23) will be classified as overweight and 26.3% (25) will be classified as obese giving an overall total of 50.53% (48 of 95) point prevalence of overweight and obese. Although, the results showed that overweight and obesity were considerably similar among girls in both 6 – 9 and 10 – 13 age groups, the prevalence (%) in term of obesity (> 85th) was slightly higher in the age group 6 – 9 years than those in age group 10 – 13 years.

The total prevalence (%) of overweight and obesity between 6 – 13 year old school children in Kuwait showed that boys (60.6%) rather than girls (50.5%) were more likely to be overweight and obese using the definition based on the Frisancho criteria (Figure 6.12).

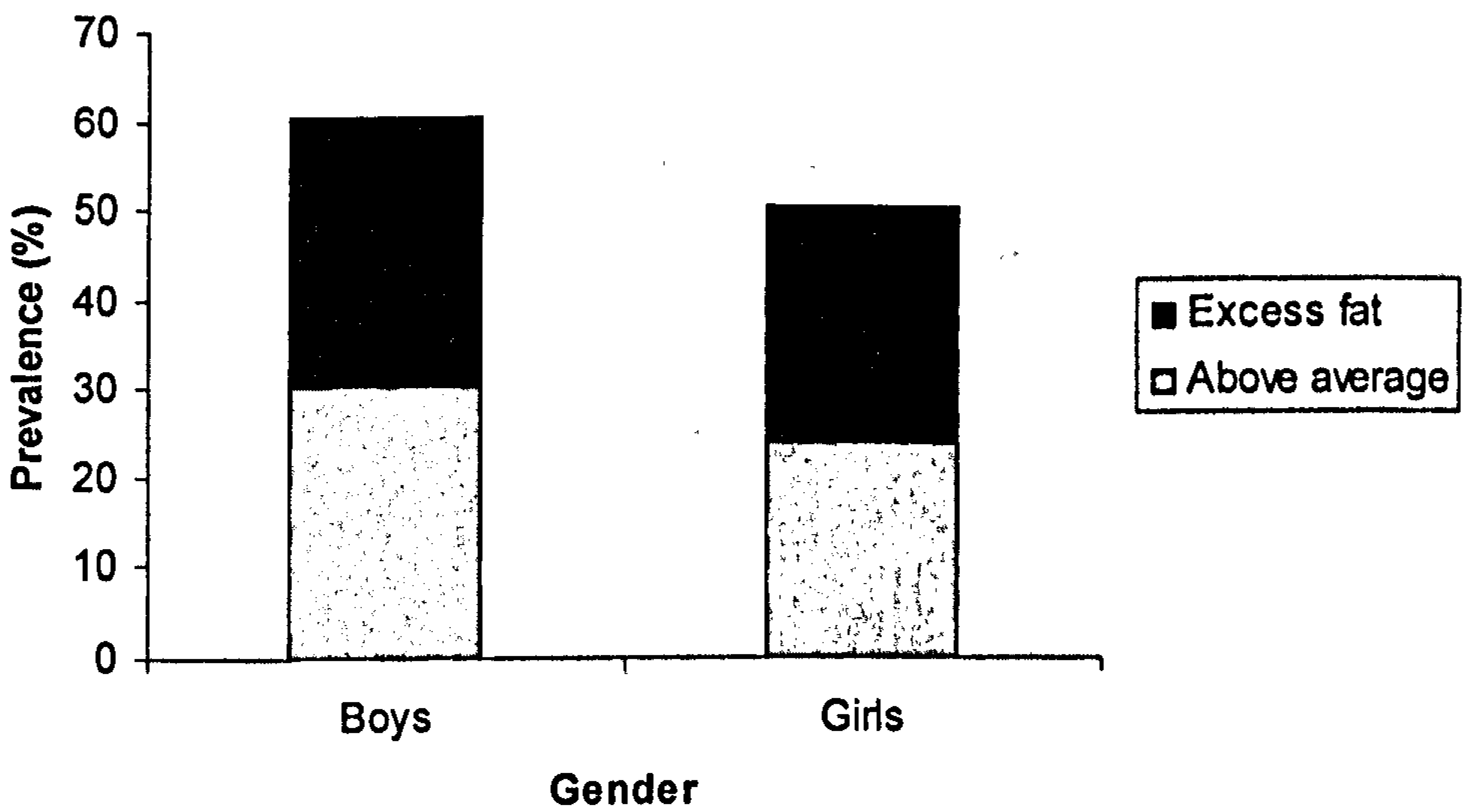


Figure 6.12 Prevalence of overweight and obesity among 194 school-age children (6 – 13 years) in Kuwait for two different genders. Overweight and obesity defined by Frisancho (1990) cut-offs reference population.

The overall prevalence and 95% CI of overweight and obesity among Kuwaiti school children in the age group 6 – 13 years are summarised in Table 6.8 using BMI and SFT indicators. The prevalence of total overweight was 65.5% (95% CI 58.1, 73.9) of Kuwaiti school-age children, based on CDC (2000) reference standards as cut-offs. Total overweight and obesity was significantly higher in girls 72.6% (95% CI 65.5, 82.3) than in boys 57.6% (95% CI 45.6, 70.5), with p-value=0.03. When using SFT indicators and cut offs (Frisancho, 1990), the total prevalence of overweight and obesity was 57.2% (95% CI 49.2, 65.8) with boys being more likely to be overweight or obese. Thus, there appears to be a discrepancy or lack of agreement between the two methods in defining obesity among boys and girls, see Figure 6.13. This observation merits further investigation in order to determine which method is more accurate for measuring obesity among school-age children. Amongst female subjects, for example, obesity as defined by BMI accounted for 35.8% of the total, compared with 26.3% for SFT. In male subjects, however, the prevalence of obesity was between 28.3 and 30.3% for the two different variables, BMI and SFT, respectively.

Table 6.8 Prevalence and 95% CI of total overweight (overweight and obese subjects) by BMI and SFT, among Kuwaiti school children in age group 6-13 year

Sex	n	Total overweight* (BMI ≥ 85% percentile) % (95% CI)	Total overweight** (SFT > 75 percentile) % (95% CI)
Boys	99	57.6 (45.6, 70.5)	60.6 (47.2, 77.9)
Girls	95	72.6 (65.5, 82.3)	50.5 (43.1, 61.7)
Total	194	65.5 (58.1, 73.9)	57.2 (49.2, 65.8)

*Overweight and obesity defined by CDC (2000) criteria. **Overweight and obesity defined by Frisancho (1990) criteria.

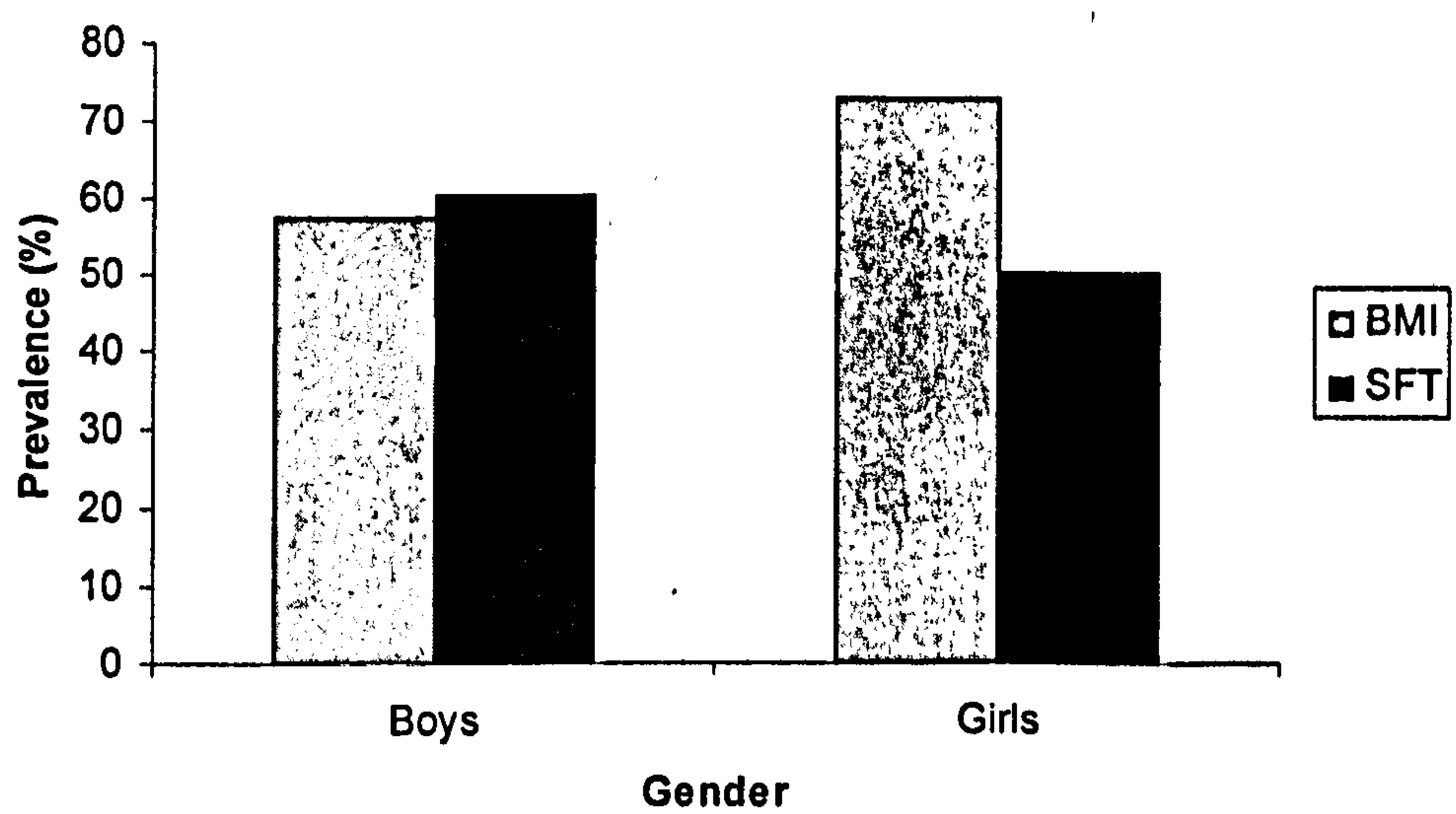


Figure 6.13 Comparison between the two different anthropometric variables (BMI and SFT) by Genders to determine the prevalence (%) total of overweight and obesity (for 194 Kuwaiti school children aged 6 – 13 year).

6.2.7 Relationship between various variables

The mutual correlations of age, PAR, EI, BMI, WHR, and skinfold thickness (SFT), were investigated for each gender, as shown in Table 6.9. All variables were correlated with one another, in other words positive and negative correlation coefficients (Pearson's) were reported amongst all variables each other, a majority of them significant at the 0.01 level. For the two different genders, age was negatively correlated with PAR but positively correlated with EI, BMI, WHR, and SFT. Physical activity ratio (PAR) was negatively correlated with EI, BMI, WHR, and SFT. Daily energy intake was positively correlated with BMI, WHR, and SFT. Body mass index had significant positive correlation with WHR and SFT. Finally, WHR had a significant positive correlation with SFT. Among all Kuwaiti school children, BMI correlations with PAR and EI were shown by Figures 6.14and 6.15, respectively.

Table 6.9 Shows results of correlations (Pearson) between various variables, including age, PAR, EI, BMI, WHR, and SFT among Kuwaiti school children aged 6 to 13 year (n=194 subjects; 99 males and 95 females)

	Age	PAR	EI	BMI	WHR	SFT
<u>Males</u>						
Age	1.000					
PAR	-.236*	1.000				
EI	.454**	-.437**	1.000			
BMI	.558**	-.670**	.538**	1.000		
WHR	.535**	-.343**	.437**	.593**	1.000	
SFT	.680**	-.502**	.555**	.735**	.585**	1.000
<u>Females</u>						
Age	1.000					
PAR	-.327**	1.000				
EI	.504**	-.580**	1.000			
BMI	.500**	-.631**	.791**	1.000		
WHR	.476**	-.369**	.603**	.597**	1.000	
SFT	.554**	-.649**	.851**	.848**	.613**	1.000

*correlation is significant at the 0.05 level (2-tailed t-test)
**correlation is significant at the 0.01 level (2-tailed t-test)

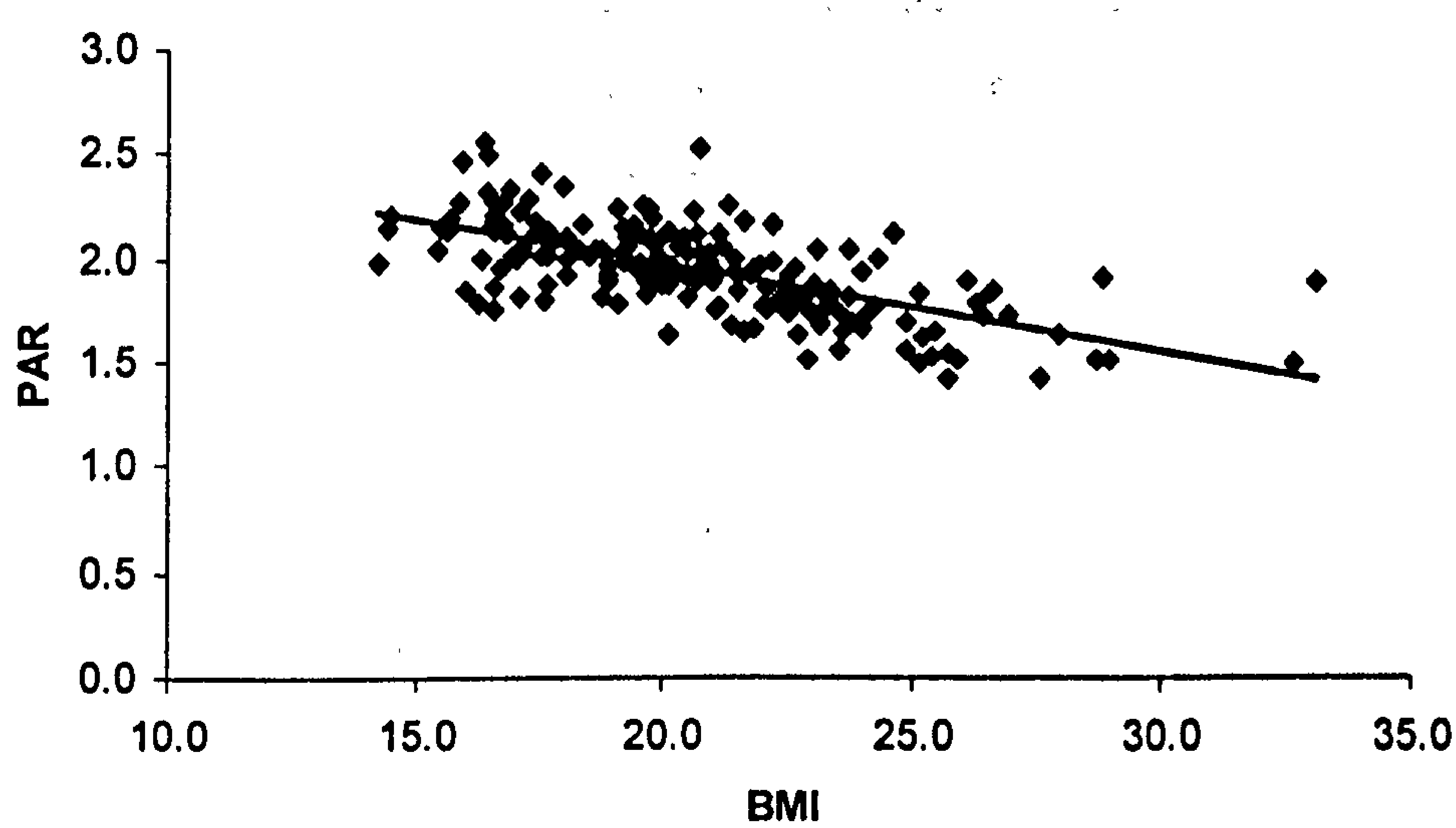


Figure 6.14 A relationship between BMI (kg/m^2) and physical activity ratio (PAR) of 6 – 13 year old school children in Kuwait. (r = -0.664).

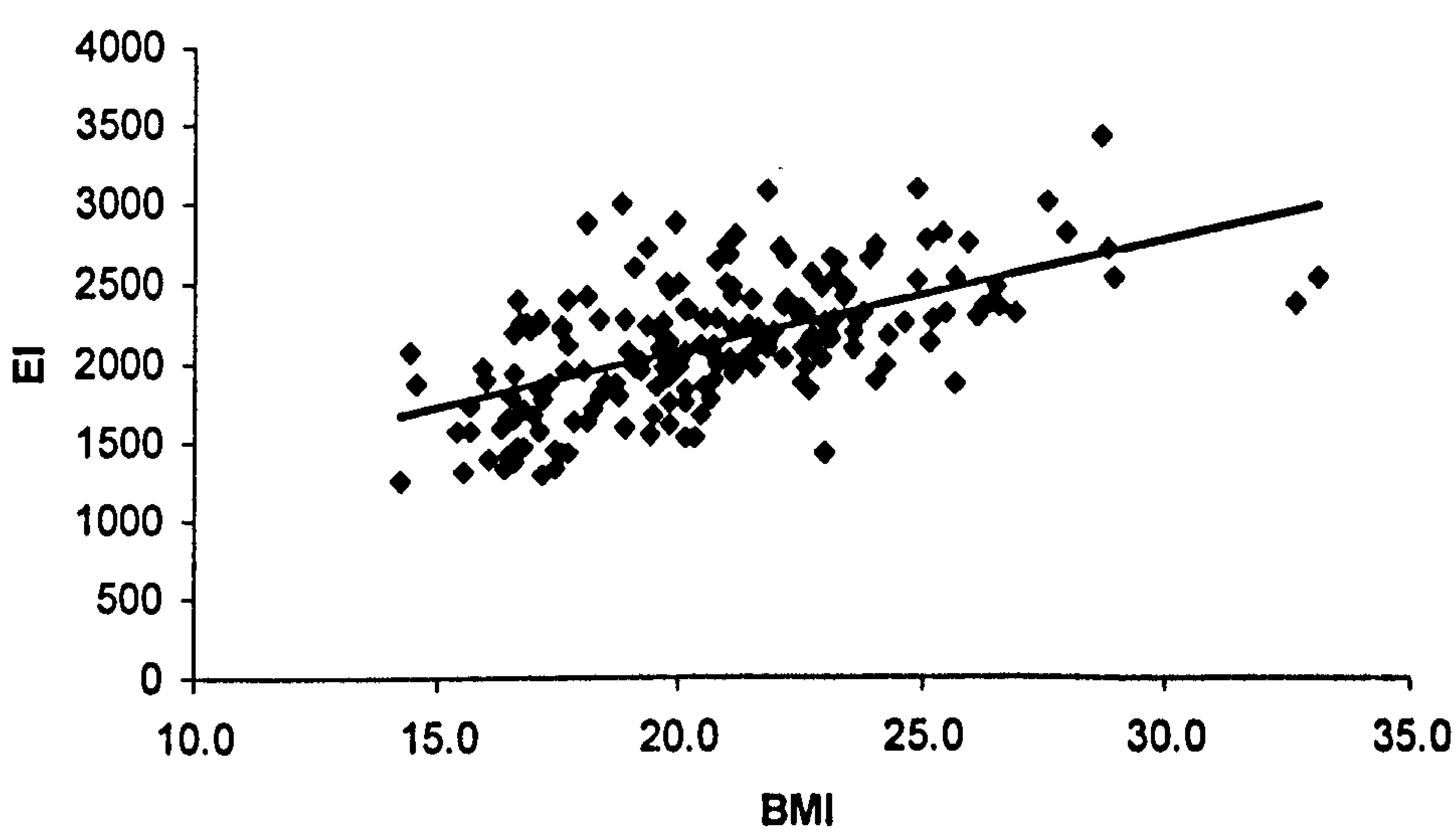


Figure 6.15 A relationship between BMI (kg/m^2) and EI (kcal/day) of 6 – 13 year old school children in Kuwait. (r = 0.584).

BMI is frequently associated with WHR and SFT measurements in children. The mean WHR in general increased with BMI (kg/m^2), Figure 6.16. However, trends in the mean

WHR varied across BMI mean values. Figure 6.17 shows that measures of skinfold thickness are correlated with body mass index in children. The results of boys SFT below 8 years remained unchanged Vs. BMI.

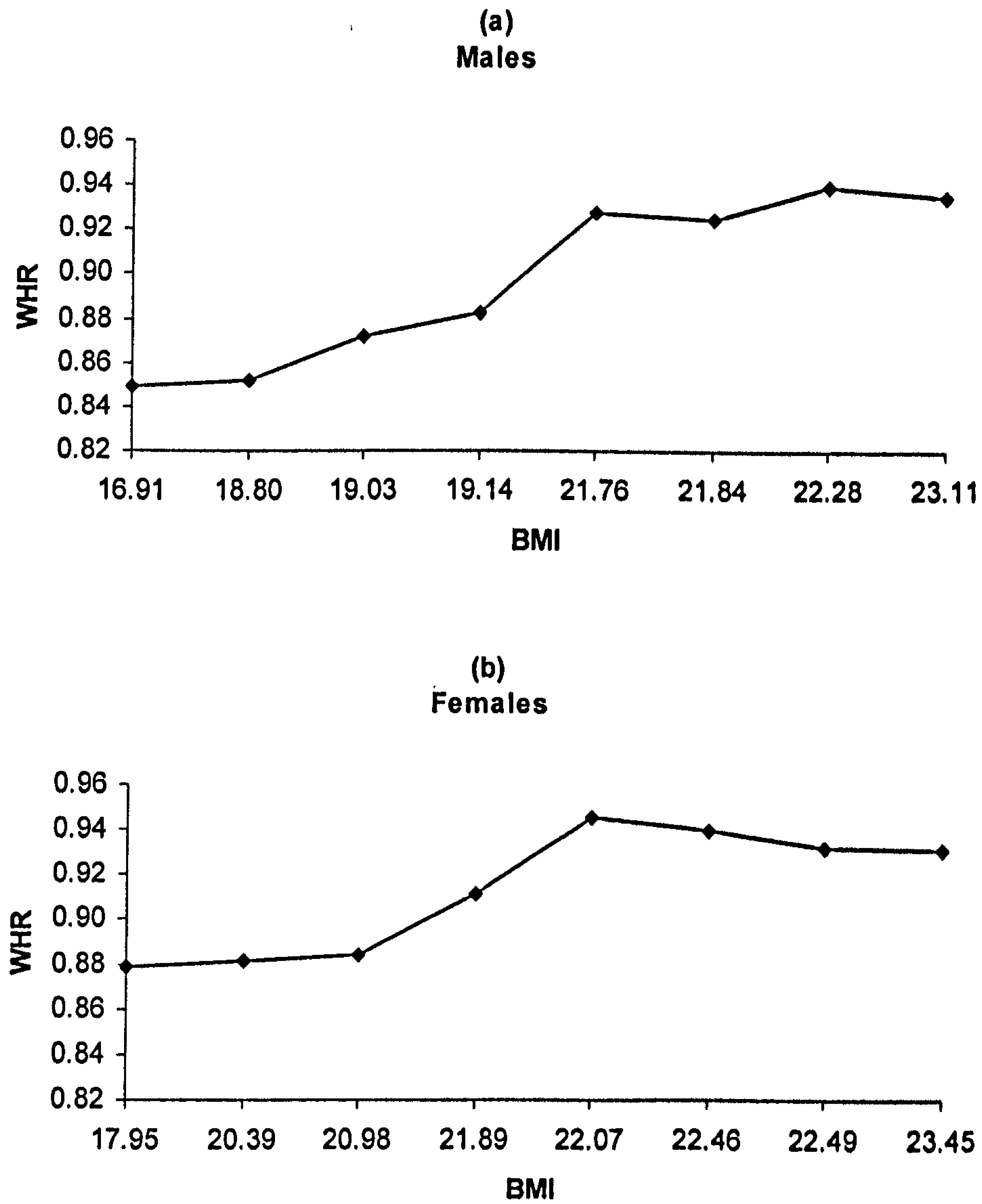


Figure 6.16 Shows body mass index (BMI) of Kuwaiti school children (boys (a) and girls (b)) aged 6 to 13 years old vs. waist to hip ratio (WHR).

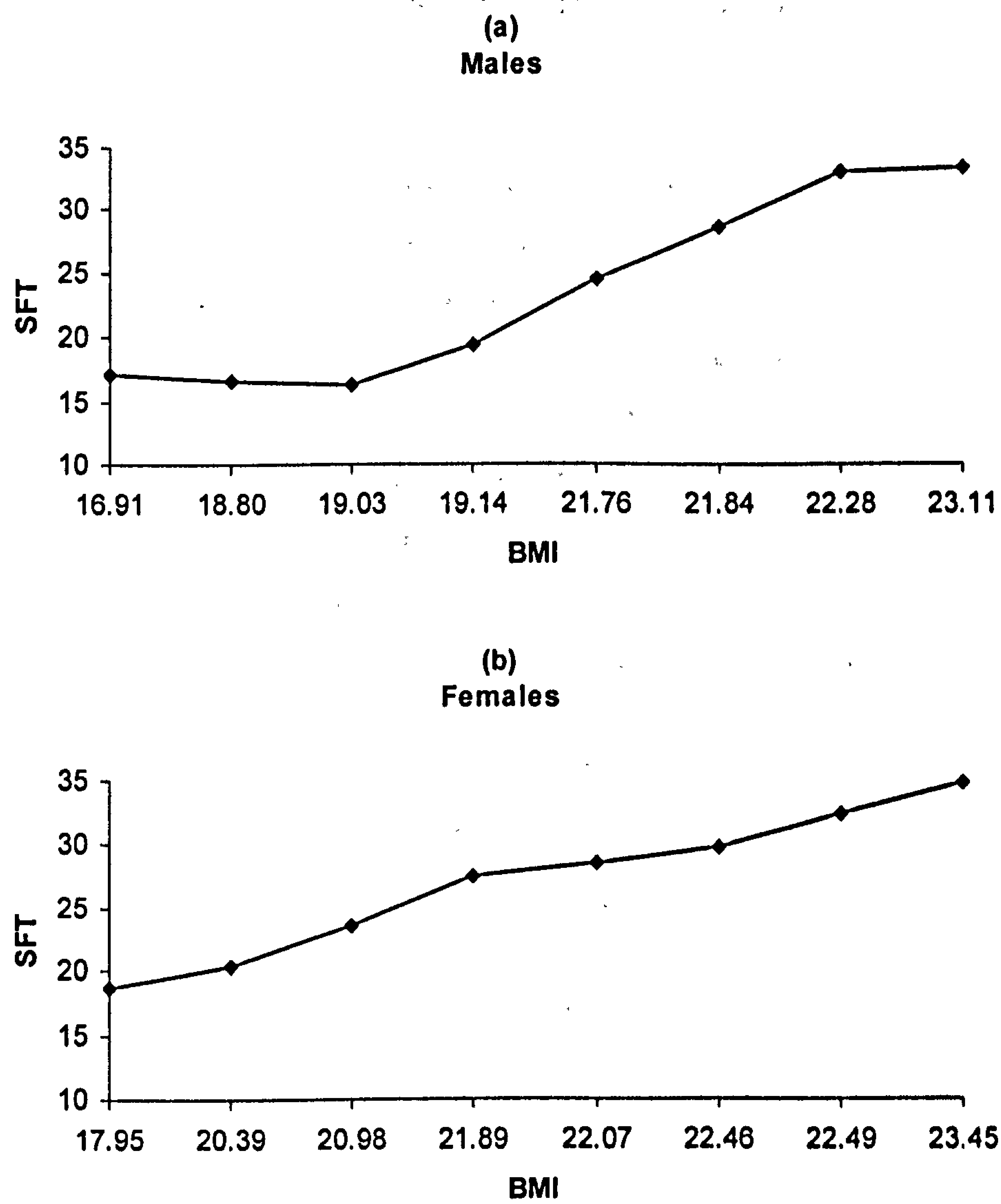


Figure 6.17 Shows body mass index (BMI) of Kuwaiti school children (boys (a) and girls (b)) aged 6 to 13 years old vs. skinfold thickness (SFT).

6.3 Discussion

The results indicated that Kuwaiti school children were found to be heavier than American children and tend to have comparable height when compared with the NCHS/CDC reference population, with no significant difference between boys and girls. The slightly drop of height for girls at age 11 to 13 years (Figure 6.2) in comparison with NCHS/CDC reference population may refer to the different environment between Kuwait and USA. In addition, these changes in height are more remarkable during puberty (Berenson *et al.*, 1981; Kouda *et al.*, 2003).

The results indicated an excess of overweight and obesity among the sample of Kuwaiti school children. Anthropometric indicators showed most children in the current study at risk of overweight and obesity, follow current international cut-offs for BMI and SFT. A comparison with Eid *et al.* (1986) study, proves present-day Kuwaiti school children are considerably heavier and taller than those in the mid Eighties. There has been a distinct and significant upward trend in weight, height, and BMI among study population compared to the year of 1984 (Figure 6.7). Furthermore, Plotting the BMI values for present study population against the study of Magbool (1994), which had reported new percentile charts for BMI for age range 6 to 16 year olds in the Eastern province of Saudi Arabia that borders Kuwait, for the first time in the region, most subjects were above the 90th centile although genetically similar. Although, Magbool (1994) study suggested that the underlying risk factor for obesity in the Eastern province school population is probably genetic, the two comparisons above elucidate that the hereditary predisposition alone cannot explain such a consistent upward trend for the genetically homogenous population. This agreed with other studies that found the genetic factors alone are not the main reason of change (Lobstein *et al.*, 2004). There is also evidence to support that the mutual correlations between variables indicated that the obesity among the study population was due to environmental factors because the three anthropometric measures (BMI, WHR, and SFT) were positively associated with daily energy intake and negatively associated with physical activity ratio (PAR).

6.4 Conclusion

As the findings of the previous chapter suggested that the sample of Kuwaiti school children is largely sedentary combined with increased positive energy balance, we conclude that, in combination with chapters 4 and 5, the environmental risk factors including lifestyle changes, physical activity and poor food choices related to rising household income are contributory in increasing the risk of obesity. High percentages of overweight and obesity among children indicated there is evidence that this population, which is in nutritional transition, are at increased risk of non-communicable diseases (NCDs) unless appropriate interventions are implemented at household and school level to reverse the trend. We suggest that preventive measures should begin in early childhood, especially since obesity in children has a strong likelihood of persisting to adulthood.

These findings will be discussed further in overall disscusion (chapter 8).

CHAPTER 7: Biochemical Measurements

7.1 Introduction

Childhood obesity carries a greatly increased risk of adult obesity, which is likely to be accentuated as adult obesity prevalence increases (Whincup and Deanfield, 2005). There is strong evidence that adult obesity is a risk factor for atherosclerotic disease, cardiovascular events, and developing type II diabetes. The risk factors for cardiovascular disease also include a number of biochemical variables, not least the lipid profile of which total triglycerides, total cholesterol and low-density liprotein (LDL) cholesterol concentrations. On the other hand, a high level of high-density lipoprotein (HDL) cholesterol has been associated with a protective effect on vascular endothelium.

Recently, metabolic syndrome (syndrome X) a new concept linking diet, overweight and obesity to endothelial dysfunction, diabetes, cardiovascular diseases and their risk indicators has been developed. It is characterised by abdominal obesity, atherosclerosis, insulin resistance and hyperinsulinemia, hyperlipidemias, essential hypertension, type II diabetes mellitus, and coronary heart disease (CHD) (Ford & Giles, 2003; Das, 2005). Identification of causes and/or etiologic factors for the development of metabolic syndrome X is important so that suitable measures can be instituted to prevent and cure the syndrome (Das, 2005; Hwallaa *et al.*, 2005). Among adolescents (12-19 years old), Cook *et al.* (2003) defined metabolic syndrome as the presence of three or more of the following risk factors: triglycerides (TG) > 110 mg/dL, fasting glucose $\geq$ 110 mg/dL, high-density lipoprotein cholesterol (HDL-c) $\leq$ 40 mg/dL, waist circumference (WC) $\geq$ 90th percentile, and/or blood pressure (BP) $\geq$ 90th percentile.

Micronutrient deficiencies can also increase health risk overall and in some cases, cardiovascular risk. Nutritional anaemia, for instance may result when inadequate dietary intake of iron is consumed and this is characterised by a decreased amount of haemoglobin. Anti-oxidant vitamins and minerals e.g. copper, selenium and zinc are known to confer some protection to the heart and blood vessels and adequate intakes are beneficial.

The previous chapter showed evidence of high prevalence rates of overweight and obesity thus increasing health risk in this sample population. To support the findings of previous chapters, attempts were made in this chapter to identify the extent to which the metabolic syndrome was prevalent among Kuwaiti school children.

The focus of this part of the study is to:

- Assess nutritional and health status of Kuwaiti school children (age: 6 – 13 years) in term of their biochemical profiles and measurements.
- Assess the prevalence of metabolic syndrome including fasting blood glucose and lipid profiles.

7.2 Methodology

Two hundred and twenty four (224) Kuwaiti school children were drawn by multistage stratified random sampling method, for more details on sampling method see chapter 3. Only 114 subjects (represents 50.9%) including 54 boys and 60 girls (mean ±SD for age was 10.3 ±2.4 years) responded to the all blood investigations required and completed informed consent (including from parents and/or guardians). The detailed procedures of blood sampling and analytical methods employed have previously been described in chapter 3 of this thesis.

Blood samples were collected and analysed for various biochemical indices including haemoglobin (Hb), fasting glucose (Glu), total triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c) and selected minerals i.e. calcium (Ca), magnesium (Mg), and iron (Fe).

The metabolic syndrome in this study was defined as the presence of three risk factors (Glu $\geq$ 110 mg/dL, TG $\geq$ 110 mg/dL, and HDL-c $\leq$ 40 mg/dL) using guidelines developed by Cook *et al.* (2003) for adolescents (12 – 19 year). Standard descriptive statistics (mean, standard deviation, standard error for mean, and 95% confidence interval) were assessed for biochemical indices.

Statistical comparisons between boys and girls were carried out employing un-paired-samples t-test with p-values <0.05 used as cut-off for statistical significance and confirmed by One Way Anova test when appropriate.

7.3 Results

7.3.1 Biochemical indices of nutritional status and risk

The results presented here are based on Kuwait reference ranges, and are presented as mean (±SD and/or ±SEM), and confidence interval (CI 95%) values for all age groups for all the parameters estimated in the blood and serum of the study population (Table 7.1).

Descriptive statistics showed some values on the upper levels or on the borderline. The results showed that the haemoglobin (Hb) content (mean ±SD) of males and females Kuwaiti school children in blood was 11.99 ±1.20 g/dL with a 95% confidence interval (CI) 11.76, 12.21 g/dL. The serum glucose concentration was 102.62 (±18.83) mg/dL (95% CI 99.12 to 106.11 mg/dL). The mean ±SD triglyceride content of the serum of subjects was 99.95 ±67.69 mg/dL (95% CI 87.39-112.51 mg/dL). The mean ±SD total cholesterol level was 173.26 ±37.45 mg/dL (95% CI 166.31 to 180.21 mg/dL). The mean ±SD high density lipoprotein cholesterol concentration of subjects was 40.69 ±13.72 mg/dL (95% CI 38.14 to 43.23 mg/dL). The mean ±SD iron content of the serum of the study population was 13.11 ±4.67 μmol/L (95% CI 12.24 to 13.97 μmol/L). Magnesium level was 0.84 ±0.06 mmol/L (95% CI 0.83 to 0.85 mmol/L) whereas calcium level was 2.35 ±0.15 mmol/L (95% CI 2.33 to 2.38 mmol/L).

When categorised by the Kuwaiti reference guidelines, prevalence of undesirable concentrations for TG and TC ranged from 21-23%, whereas 72-74% of participants' TG and TC levels were within the reference range. Similarly, prevalence of undesirable concentrations for HDL-c was 38.6% of participants. On the other hand, fasting glucose levels above 109 mg/dL were found approximately 30%, and only 68% of Hb levels were within the reference range (11.5-15 g/dL) and almost 86-90% of participants had minerals levels within the Kuwaiti reference values.

Table 7.1 Overall mean values and other descriptive statistics (standard deviation, standard error mean, 95% confidence interval) of biochemical indices (n = 114; 54 male and 60 female) for the study group aged 6-13 year*

Variable (unit)**	Biochemical index classification (in Kuwait)	Participants in each classification N	%	Mean	SD	SEM	CI (95%)	P-value
Hb (g/dL)	< 11.50	36	31.6	11.99	1.20	0.11	11.76, 12.21	0.28
	11.50-15	78	68.4					
	> 15	0	0					
Glu (mg/dL)	< 70	0	0	102.62	18.83	1.76	99.12, 106.11	0.14
	70-109	80	70.2					
	> 109	34	29.8					
TG (mg/dL)	< 32	6	5.3	99.95	67.69	6.34	87.39, 112.51	0.04
	32-131	82	71.9					
	> 131	26	22.8					
TC (mg/dL)	< 120	5	4.4	173.26	37.45	3.51	166.31, 180.21	0.96
	120-200	84	73.7					
	> 200	25	21.9					
HDL-c (mg/dL)	< 35	44	38.6	40.69	13.72	1.28	38.14, 43.23	0.005
	35-85	68	59.7					
	> 85	2	1.7					
Fe (μmol/L)	< 9	9	7.9	13.11	4.67	0.44	12.24, 13.97	0.10
	9-21.50	98	86.0					
	> 21.50	7	6.1					
Mg (mmol/L)	< 0.70	3	2.6	0.84	0.06	0.01	0.83, 0.85	0.22
	0.70-0.88	102	89.5					
	> 0.88	9	7.9					
Ca (mmol/L)	< 2.20	12	10.5	2.35	0.15	0.01	2.33, 2.38	0.56
	2.20-2.70	102	89.5					
	> 2.70	0	0					

* Mean ±SD for age was 10.3 ±2.4 years and the response rate was 50.9% (114) of 224 subjects.
**Conversion units of reference values: Glu = 70-109 mg/dL (× 0.0555) = 3.9-6.0 mmol/L; TG = 32-131 mg/dL (× 0.0113) = 0.36-1.5 mmol/L; TC = 120-200 mg/dL (× 0.0259) = 3.1-5.2 mmol/L; HDL-c = 35-85 mg/dL (× 0.0259) = 0.90-2.2 mmol/L; Fe = 50-120 μg/dL (× 0.179) = 9.0-21.5 mmol/L; Mg = 1.7-2.15 mEq/L (× 0.4114) = 0.70-0.88 mmol/L; and Ca = 8.8-10.8 mg/dL (× 0.25) = 2.2-2.7 mmol/L

Statistically, no significant differences were found for Hb, Glu, TC, Fe, Mg, and Ca between males and females. However differences in HDL-c values between males and females were found to be highly significant (p = 0.005) with higher values in females. Similarly, differences in serum triacylglycerol (TG) levels between males and females was statistically significant (p = 0.04) (Table 7.1).

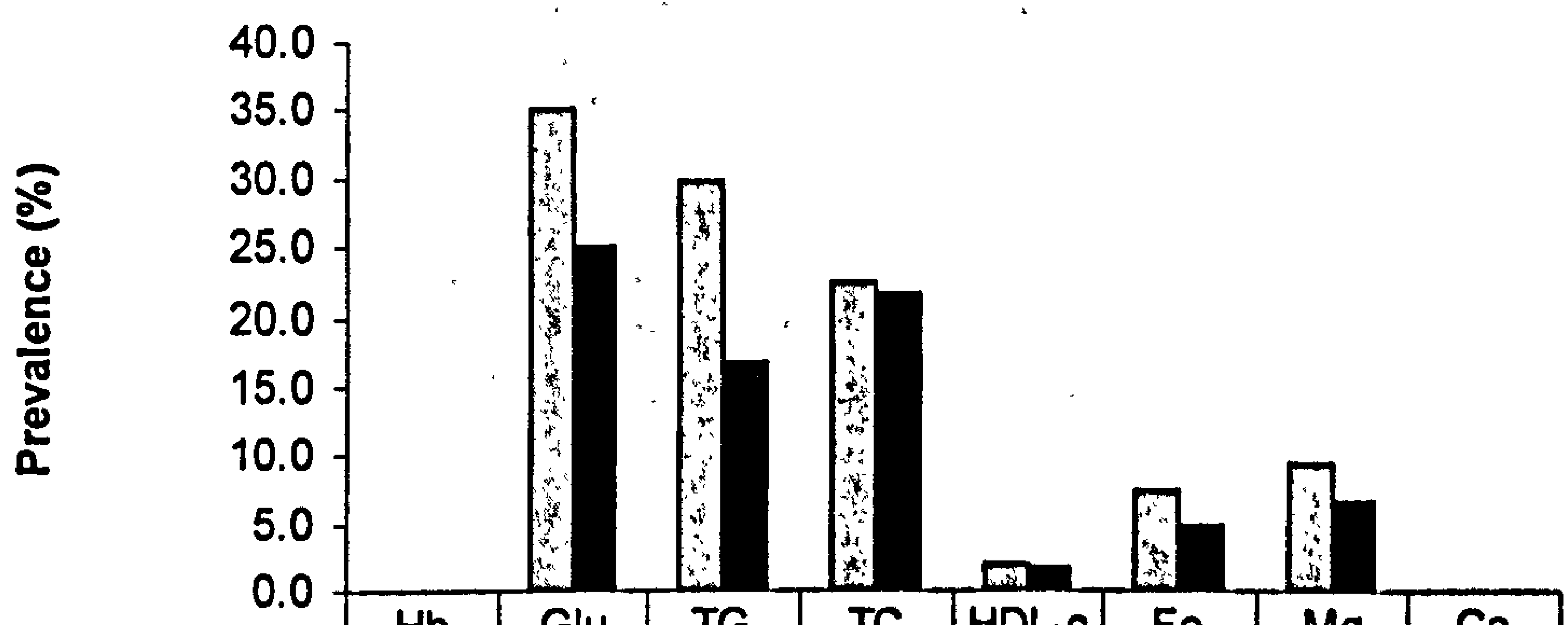
7.3.2 Biochemical evidence of exposure to health risk according to the Kuwaiti reference range

The distribution of biochemical indices of Kuwaiti school children aged 6 – 13 years below the Kuwaiti normal limits are presented in Figure 7.1. Seventeen of 54 boys (31.5%) had blood haemoglobin levels below 11.5 g/dL while 19 of 60 girls (31.7%) had blood haemoglobin levels below 11.5 g/dL. As shown in the figure, no subjects were found to have fasting serum glucose levels below the reference range. Two of 54 male subjects (3.7%) and 4 of 60 females (6.7%) had serum TG levels below 32 mg/dL. The overall mean serum total cholesterol (TC) levels were below 120 mg/dL for 2 male subjects (3.7%) and 3 female subjects (5.0%). However, high-density lipoprotein cholesterol (HDL-c) concentration was below the Kuwaiti reference range in 27 of 54 males (50.0%) and 17 of 60 females subjects (28.3%). For minerals, iron concentration was below the Kuwaiti reference values in one male (1.9%) and 8 females (13.3%). Magnesium concentrations were lower than 0.70 mmol/L in one male (1.9%) and 2 females (3.3%). Calcium concentration was below the Kuwaiti reference range in 5 boys (9.3%) and 7girls (11.7%).

	Hb	Glu	TG	TC	HDL-c	Fe	Mg	Ca
□ Male %	31.5	0.0	3.7	3.7	50.0	1.9	1.9	9.3
■ Female %	31.7	0.0	6.7	5.0	28.3	13.3	3.3	11.7

Figure 7.1 Percentage of school children who had low blood levels of Hb, Glu, TG, TC, HDL-c, Fe, Mg, and Ca based on Kuwait reference range aged 6 to 13 year (54 males and 60 females; and the mean ±SD for age was 10.6 ±2.3 years for males and 10.1 ±2.5 years for females).

The percentage (%) of Kuwaiti school children between 6 and 13 years of age who had an overall average of biochemical indices above the normal range were presented by Figure 7.2. No subjects were found had Hb levels higher than the normal reference values. However, nineteen males (35.2%) from over 54 participants in glucose blood test were found above the normal limits while fifteen of females (25.0%) over 60 participate above the glucose normal levels. Those with serum TG levels above 131 mg/dL were 16 of 54 males (29.6%) and 10 of 60 females (16.7%). Similarly, the serum TC levels were above 200 mg/dL for 12 of 54 males (22.2%) and 13 of 60 females (21.7%). HDL-c concentration was exceeding the Kuwaiti reference range in one subject for each gender (1.9% for males and 1.7% for females). Among minerals, serum calcium levels above 2.7 mmol/L were not recorded, however, iron concentration was exceeding the Kuwaiti reference range in 4 of 54 males (7.4%) and 3 of 60 females (5.0%). Magnesium concentration was above the Kuwaiti reference values in 5 of 54 males (9.3%) and 4 of 60 females subjects (6.7%).



	Hb	Glu	TG	TC	HDL-c	Fe	Mg	Ca
□ Male %	0.0	35.2	29.6	22.2	1.9	7.4	9.3	0.0
■ Female %	0.0	25.0	16.7	21.7	1.7	5.0	6.7	0.0

Biochemical Indices

Figure 7.2 Percentage of school children who had excess blood levels of Hb, Glu, TG, TC, HDL-c, Fe, Mg, and Ca based on Kuwait reference range aged 6 to 13 years (54 males and 60 females; and the mean ±SD for age was 10.6 ±2.3 years for males and 10.1 ±2.5 years for females).

7.3.3 Relationship between various biochemical variables

Pearson's correlation coefficients (r) between the variables for all age groups and both sexes are shown in Table 7.2. Inter-correlations were apparent, a few of them significant at the P.005 level and few others significant at P.001. For example, age had a significant negative correlation with magnesium levels whereas haemoglobin had a significant positive correlation with iron. Fasting glucose levels had a significant positive correlation with triglycerides but a significant negative correlation with high-density lipoprotein cholesterol and magnesium. Triglycerides had a significant positive correlation with total cholesterol and significant negative correlation with high-density lipoprotein cholesterol. The results also showed other positive correlations such as between age and glucose (r = 0.166), and other negative correlations such as age with TC, Fe, and Ca (r = -0.310, -0.133, and -0.184, respectively). Haemoglobin was negatively associated with triglycerides and positively associated with magnesium. HDL-c was negatively correlated with the minerals (iron, magnesium, and calcium) (Table 7.2).

Table 7.2 Pearson's Correlation Matrix (all ages and genders)

	Age	Hb	Glu	TG	TC	HDL-c	Fe	Mg	Ca
Age	1.000								
Hb	0.011	1.000							
Glu	0.166	-0.088	1.000						
TG	-0.006	-0.157	0.190*	1.000					
TC	-0.310	-0.037	0.046	0.189*	1.000				
HDL-c	0.137	0.076	-0.229*	-0.571**	-0.012	1.000			
Fe	-0.133	0.410**	0.006	0.150	0.105	-0.166	1.000		
Mg	-0.228*	0.133	-0.206*	0.056	-0.030	-0.145	0.095	1.000	
Ca	-0.184	-0.111	-0.024	-0.027	0.095	-0.061	-0.090	0.024	1.000

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

7.3.4 Metabolic syndrome

To identify the number of children at risk of metabolic syndrome Cook *et al.* (2003) criteria were used. The criteria used for metabolic syndrome were provided in Table 7.3. Based on such criteria, the levels of fasting glucose, triglycerides, and HDL-c were used among the sample population. It is attempted to predict the percentage of Kuwaiti school children at risk of metabolic syndrome with these three factors.

Table 7.3 Criteria for Metabolic syndrome

	Kuwaiti Guidelines	Metabolic syndrome[a] Guidelines
Glucose, mg/dL	Desirable 70-109	≥ 110
Triglycerides, mg/dL	High > 131	≥ 110
High Density Lipoprotein, mg/dL	Acceptable ≥ 35	≤ 40

[a] Defined as the presence of three risk factors using guidelines developed by Cook *et al* (2003) study.

The presence of individual components of the metabolic syndrome were calculated and used to assess differences in prevalence of metabolic syndrome by gender. In general, metabolic abnormalities were more likely to be seen in males than females. Table 7.4 summarises frequencies of the number of features of the metabolic syndrome. The prevalence of one risk factor or more was 74.1% among males and 55.0% among females, with total 64% (95% CI 55.2, 72.8). Similarly, 53.7% of the males had two risk factors or more compared to 30.0% of the females. Overall, the metabolic syndrome (presence of 3 features) occurred in 14.9% (95% CI 8.4, 21.4) of participants. While 20.4% of the males had three risk factors, only 10.0% of the females fell in this category.

Table 7.4 Prevalence of one or more components of the metabolic syndrome in subjects

Sex	n	% (95% confidence interval)		
		≥ 1 risk factors	≥ 2 risk factors	3 risk factors
Male	54	74.1 (62.4, 85.8)	53.7 (40.7, 67.0)	20.4 (9.7, 31.1)
Female	60	55.0 (42.4, 67.6)	30.0 (18.4, 41.6)	10.0 (2.5, 17.5)
Total	114	64.0 (55.2, 72.8)	41.2 (32.1, 50.2)	14.9 (8.4, 21.4)

The distribution of each biochemical variable of the metabolic syndrome is shown in Table 7.5. The prevalence of glucose level in excess of 110 mg/dL was 31.5% among males and 23.3% among females, with total 27.2% (95% CI 19.1, 35.3). For triglycerides, the values of 34.2% (95% CI 25.5 to 42.9) exceeded the threshold limit of Cook *et al.* (2003). The HDL-c level was less than 40 mg/dL in 56.1% (95% CI 47.0, 65.2) of the sample. Overall, low HDL-c levels were most common, whereas high TG and fasting Glu levels were the least common. Individual risk factors were higher for males than females for all three risk factors.

Table 7.5 Prevalence of individual metabolic syndrome risk factors

Sex	n	% (95% confidence interval)		
		High Glu	High TG	Low HDL-c
Male	54	31.5 (19.1, 43.8)	40.7 (27.6, 53.8)	70.4 (58.2, 82.5)
Female	60	23.3 (12.6, 34.0)	28.3 (16.9, 39.7)	43.3 (30.8, 55.8)
Total	114	27.2 (19.1, 35.3)	34.2 (25.5, 42.9)	56.1 (47.0, 65.2)

7.4 Discussion

In previous chapters, I have shown a relationship between socio-demographic factors, health habits, lifestyle, food choice and risk of overweight and obesity among Kuwaiti school children. In this chapter, there is evidence that HDL-c levels are relatively low compared to reference values, particularly among males. The pooled mean values of HDL-c among Kuwaiti school children were lesser than those reported by Sur *et al.* (2005) for normal Turkish school children. They found that the mean HDL-c values decreased in obese boys and girls.

Although blood glucose levels and total triacylglycerols and serum cholesterol levels were within the range of normal values, the tendency was generally towards the higher side of normal in these age groups. The results of biochemical indices in this section also indicate that about 30% of school children of the current study are likely at risk of different non-communicable diseases such as anaemia with no previous knowledge to either themselves or their parents.

Most pooled mean values of biochemical parameters were on the upper side of the normal range. While these levels exceeded some similar affluent populations' values, they agreed with others. Several previous studies have attributed such high levels of biochemical indices to the nutritional transition stage due to the change of lifestyle and food habits (El-Hazmi and Warsy, 2001; Al Mousa *et al.*, 2003; Pinhas-Hamiel *et al.*, 2003; Brage *et al.*, 2004).

Among current study population, 14.9% had all the three risk factors i.e. achieved the criteria of syndrome X (Table 7.4). In their study of obesity and risk factors for the metabolic syndrome among African American school children (ages 8 – 12 years), Braunschweig *et al.* (2005) found that all students who met the criteria for the metabolic syndrome were overweight and no normal weight participant had more than one risk factor. The higher overall rates for the metabolic syndrome in our participants than those reported by Braunschweig *et al.* (2005) and Cook *et al.* (2003) probably reflect the increase in obesity prevalence among Kuwaiti students. Unfortunately, our sample (114 subjects) is too small to assess rates those who had the metabolic syndrome according to BMI percentile categories. A recent pilot study of 1700 multi-ethnic 8^{th} grade children found that 13.9% had the metabolic syndrome based on Adult Treatment Panel III guidelines (STOPP-T2D, 2004), which is almost close to our finding. Despite the differences in design, these studies collectively show that the metabolic syndrome is present in a significant number of fairly young overweight children.

The results of this study also underlined that 64% of 114 subjects having one or more risk factors of the metabolic syndrome. As total overweight and obesity among school children in current study was 57.2% based on SFT or 65.5% based on BMI standards (Table 6.8), approximately half of them were classified as obese, it will not be surprising when those who had one or two risk factors become victims of metabolic syndrome soon, as a consequence of the rapid progress of comfortable lifestyle. Therefore, a majority of Kuwaiti children attending primary and intermediate schools were overweight and/or had one or more metabolic syndrome risk factors.

7.5 Conclusion

We conclude that the current results support previous findings that the Kuwaiti school children are at increased risk of being overweight and obese since the findings on the biochemical indices indicate a considerable proportion of the subjects are at risk of obesity-related non-communicable diseases. Furthermore, the fact that 14.9% of the study population had all the three risk factors for metabolic syndrome proves the non-absence of environmental causes on the high prevalence of obesity among Kuwaiti school children.

It seems reasonable at this stage to suggest early detection of high risk groups as part of primary prevention strategies within the Kuwaiti population, which has the highest reported prevalence of cardiovascular morbidity and mortality throughout the Arab Gulf region (Alsaif *et al.*, 2002).

These findings will be discussed further in next chapter (chapter 8).

Chapter 8: Overall discussion and conclusion

8.1 Introduction

The fact that Arabian Peninsula States are passing through a phase of economic and demographic transition is well known. Rising income levels and purchasing power have been accompanied by changes in lifestyle, food choices, types and levels of physical activity and ultimately health habits. Kuwait along with other Arab Gulf States is increasingly becoming a sedentary society and as has been previously reported has increasing levels of obesity and non-communicable diseases (NCDs). This study focused on examining secular trends in nutritional status among 6 to 13 year old school children with the view to identify non-hereditary (environmental) risk factors which may be the direct (or indirect) result of economic prosperity and how these can be translated into public health risks for this age group as well as future generations.

In previous chapters of this thesis, specific findings from the different aspects of methodology have been presented with analysis of these findings. The focus of this chapter is to make relevant deductions which take into account the individual findings and evaluate their significance in order to provide a scientific basis for drawing meaningful conclusions about the work and making relevant recommendations which may have policy implications in Kuwait.

8.2 Evaluation of impact of socio-demographic transition on food-related behaviour and physical activity levels among the school-age population

The assessment of current socio-economic status is useful to identify the impact of socio-economic transition on school children in Kuwait. For this purpose, specific questionnaire (Appendix 2), as an initial tool, was employed in the present study. This questionnaire is also to get preliminary information on the nutritional status of the sample population, before the study progressed to sophisticated investigations such as 7-days dietary and activity record methods on a sub-sample of study population.

8.2.1 Socio-demographic indicators and their relation to overweight and obesity

Recent studies Gahagan (2003; 2004) have suggested a strong link in relative risk of overweight with family size with a doubling of the risk where there is an only child. In the present study, we have found that the number of households with 4 or more siblings has decreased over the last few years from 76.3% (Moussa *et al.*, 1999) to 62.5% (current study), whilst over the same period, the number of households with 3 siblings and below, has increased 1.58-fold from 23.7% (1999) to 37.6% (2004) thus suggesting that if sibling size is a proxy measure of risk of overweight and obesity, then these secular trends suggest an increasing public health risk among the average Kuwaiti families.

Similarly, an incongruous (inverse) relationship has recently been reported between parental education and serum cholesterol levels in Turkey (Kocaoglu *et al*, 2005) where children of parents with medium to higher educational levels had higher total serum cholesterol levels. Earlier, Koçoglu *et al.* (2003) had reported an increased risk of obesity among Turkish school-age children (11-14 years old) from higher income households (families) compared to those from poorer backgrounds. In this study we have shown that parental secondary to higher educational level in Kuwait has risen 1.14-fold among fathers and 1.53-fold among mothers over the last five years. Furthermore, Kuwaiti household incomes have risen 1.12-fold for middle to high-income families over the same period with 71.1% of families of the sample population belonging to moderate or high income brackets according to international classification of income or socio-economic class. Over the last decade, it has been reported that Kuwaiti families have in real terms, seen a 7.5% and 4.5% shift from low to moderate; and moderate to high income levels respectively (Moussa *et al.*, 1999). It appears that these apparent socio-economic advantages may not have translated into positive health and nutritional benefits to our study population. On the contrary, these non-hereditary (socio-demographic) and modifiable factors may inadvertently, contribute to the risk of sedentary behaviour and increased energy consumption among children, thus predisposing to overweight and obesity, the evidence of which has been reported in this study with 53.6% of 6 to 13 year old boys being either overweight or obese (Cole *et al.*, 2000 classification) or 57.6% of boys being overweight or obese (CDC 2000 Classification). Similarly, 71.6% of girls of the same age group were either overweight or obese (Cole *et al.*, 2000 classification) or 72.6% of them according to the CDC classification (Table 6.6). These findings have implications for public health and especially nutrition education in schools.

8.2.2 Food-related behaviours and lifestyle factors

Traditional, home-made and well-balanced diets would have potential health benefits compared to convenience or fast foods. However, the evidence from this study suggests that the majority of Kuwaiti school-age children prefer fast foods to home-made ones for a variety of reasons which need to be taken into account in planning any targeted health promotion activities including nutrition education and lifestyle modification. The fact that of the 1536 subjects included in this study, 56.5% of boys and 63.1% of girls always preferred fast foods compared to only 17.6% and 12.5% of boys and girls respectively who always avoided this variety of foods from outside the home has huge implications in terms of the impact of parental influence on their food-related behaviour.

In chapter 4 of this thesis, some findings which suggest a huge influence of external factors in food-related behaviour in this sample population have been highlighted (using health habits and history questionnaire i.e. Appendix 2). For instance, television advertisements account for 80.2% of influence among boys and 86.6% among girls. This suggests that Kuwaiti school age children are permitted by their parents to spend time watching television (as evidenced in Table 4.3). Quite apart from adding to sedentary activity, the images and advertisements of food seem to have an influence on food preference corroborating the findings of Hitchings and Moynihan's (1998). Furthermore, 75.1% of all children were attracted by advertising and toy gifts provided by fast food restaurants. Surveys conducted in the US have revealed a similar pattern of behaviour where adolescents aged 12 – 18 years were found to increasingly rely on foods eaten outside particular fast foods rather home-made foods (Lin *et al.* 1999; St-Onge *et al.*, 2003). According to Zoumas-Morse *et al.* (2001) children consume more energy when meals are eaten in restaurants than at home, possibly because restaurants tend to serve larger portions of energy dense foods. These observations introduce an interesting dimension to any future planning of health messages and nutrition-related health promotion among this population sub-group including the use of healthy varieties in place of less healthy options (Table 5.1) and the introduction of tokens as rewards for those who choose healthy foods.

Other important influences on food choices were peers with nearly 70% of all children being influenced by what their friends choose to consume. This also introduces an interesting opportunity to use the child-to-child approach to spreading healthy messages about food among school-age children in this environment. In their strategy to improve weight management, Klein *et al.* (2004) realised that friends are important factor in modifying lifestyle behaviour. Therefore, through good nutrition education at school level, children can act as their own mentors in order to influence dietary modification among their peers. Such programmes however need to be well thought out and planned to achieve success and be sustained.

Of least influence among this cohort of school-age children were their own parents (27.3% influence) and health professionals i.e. doctors and other allied health workers who were consulted on dietary matters for these children in less than 4% of cases. It would have been expected that in a traditional, relatively conservative society like Kuwait, parental influence would play a major part in food choice in the school-age population. These findings seem to suggest that this is far from the case, and that changes and influences in this population in economic and nutritional transition has permeated all sections of the life cycle. The implications of this for planning and execution of health promotion activities targeting the school age population cannot be overstated. Two key issues that need to be addressed are: the permissiveness of parents towards the freedom of watching television (more than is necessary from which advertising influences arise) and parental encouragement of eating outside the home (fast food restaurants from which adverts and gifts continue to influence patronage and therefore food choices) (Taras & Gage, 1995; Robinson, 1999; Robinson, 2000; Borzekowski & Robinson, 2001; Bowman *et al.*, 2004).

This study has also revealed a markedly sedentary lifestyle among our sample population. This is evidenced by the fact that less than 8% of the population walked to school, irrespective of how distant the school was from the home. Although, students in Kuwait prefer to go by car as they are used to a comfortable lifestyle, parents may not allow their children to walk fearing their safety as traffic accidents are quite common in Kuwait. This highlights the need for the construction of safe routes to school in any future programme for the prevention of childhood obesity. Walking to school could be an easy outdoor habitual form of physical activity which should not be seen as a chore and building a mentality of this practice would contribute positively to good lifestyle modification (James, 2000). However, only 18.3% of the study population undertake any form of prescribed or 'intentional' physical exercise for a period of more than 2 hours although overall, 38% of boys and 16% of girls undertake some form of exercise. This can be explained based on the fact that Kuwait has a critical climatic factor that prevent children from exercising (summer extends to eight months). Only 10.6% of surveyed subjects enjoyed 'daily' exercising in hot weather. Similar findings suggested that a hot climate-country like Saudi Arabia does not encourage individuals to indulge in many physical activities (El-Hazmi & Warsy, 1997), leading to a high prevalence of non-insulin-dependent-diabetes mellitus, overweight and obesity (El-Hazmi & Warsy, 2001). However, 61% of boys and 38.7% of girls reported actually enjoying their exercises if they choose preferable type. This latter finding could be utilised in the planning of interesting and enjoyable physical activity programmes for school-age children in Kuwait. Therefore, sports promotion with adequate resources should be directed towards the encouragement of preferable exercises for children and need to be centred on school and community programmes, which are consequently likely to be more sustainable.

Further evaluation of these findings have focused on the influence of a number of lifestyle and behavioural predictors of risk of overweight and obesity using 19 validated variables (Table 4.4) (Gillman *et al.*, 2000; Saelens *et al.*, 2002). Using these 19 variables and analysing the response rates in terms of their influence on individuals across the age ranges (i.e. 6 to 13 years), the overall mean values of risk prediction showed that 64.1% of boys, 68.4% of girls and an overall average of 66.3% (95% CI 56.7 – 75.8) of the sample population experienced habits and lifestyle behaviours that are strong predictors of risk of overweight and obesity. This finding is consistent with the quantitative values obtained of the point prevalence of overweight and obesity in this study based on measurements of BMI which have been reported above and are also represented in Tables 6.6 and 6.8. These observations are corroborated by a recent study by Serra-Majem *et al.* (2006) who showed that socio-demographic factors, including a family's socioeconomic status are significant predictors of obesity in Spanish children and adolescents (under 14 years). It is our view that this new approach could serve as yet another proxy measure of childhood obesity risk within a population (and cultural) context. This hypothesis however needs to be investigated further for validity in a larger population sample and with different age groups.

8.2.3 Health implications

As is well known, environmental risk factors for obesity are exacerbated by relevant exposure variables including lifestyle factors and food choices, leading to risk modification. The risk would be accelerated if more negative exposure variables are experienced by the individual. In this study (by using health habits and history questionnaire), I have demonstrated in particular, the important determinants of food choices i.e. TV adverts, fast food restaurants and peer or child-to child influences. On the contrary, parental influence and that of health professionals as well as the influence of school or governmental dietary programs has been very minimal.

The evidence provided suggests a population at high risk of exposure (66.3% risk). This evidence is supported by the findings from physical measurements which indicate that over 60% of the sample population is either overweight i.e. above 85th percentile for BMI or obese i.e. over 95th percentile for BMI. The health implications of this picture can be translated into risks of morbidity to non-communicable diseases which are increasingly being reported in childhood (Freedman *et al.*, 1999; Freedman *et al*, 2002; Dalton *et al.*, 2003; Nassis *et al.*, 2005). Furthermore, some of this morbidity may have an early onset or occur in later adolescence especially lipid disorders, atherosclerosis, diabetes type II and hypertension which all predispose to the metabolic syndrome with huge clinical consequences for the individual. An attempt has been made to address the biochemical evidence for these health risks and this will be further evaluated in this chapter.

8.3 Relationship between energy intake, physical activity and public health

There is clear evidence of a link between food choice and energy intake with a tendency towards increased intake across the age groups and between boys and girls. From this study it is evident that some of the most important reasons for the increased intake of energy are frequent consumption of foods high in fat (especially saturated fat), protein, and frequent consumption of carbonated soft drinks at the expense of healthy foods, e.g. fresh fruits and vegetables which are the main source of non-starch polysaccharides (Table 5.1).

In spite of the fact that a balanced reduced calorie diet almost has been focused by scientists and dieticians as one of the important dietary guidelines, this study has shown that both genders for all age groups, energy intakes exceeded the UK dietary reference values (EAR values) (Table 5.2). When adjusted for body weight, differences in energy intake between boys and girls overall shows a tendency towards statistical significance thus suggesting a possible role for weight-adjusted energy intakes as a discriminator of intakes among children of different sexes and provide extra evidence that the current subjects are consuming high energy (Table 5.3). This high intake of energy is not being expended via physical activity i.e. there is a positive energy balance (intake vs. expenditure) directly elucidates the increase risk of obesity among surveyed subjects (Figure 5.4). Jequier, (2002) concluded that if energy intake exceeds expenditure by only 5% every day, this result will be equal to gain of 5 kg fat mass per year. Over several years, this small 5% every day will lead to morbid obesity. Nonetheless, obesity risk decreased by 10% for each hour per day of moderate-to-vigorous physical activity (Hernandez *et al.*, 1999).

In term of the components of energy intake, the results have indicated that the total fat intakes were high compared to recommended values (Department of Health, 1991; 2003). Fat consumption as a percentage of total daily energy intakes (TEI) was on average 37.2% which was higher than that obtained from the NHANES III study for USA subjects (NHANES III, 2000), see Figure 5.2, because the actual amount of fat in the daily diet is high. The amount of fat that was consumed by subjects in the current study on average equalled 85.9 g/d which is nearby to consumption levels among British adults (Department of Health, 1991; 2003), where the total daily intake of fat by the British population was 87.8 g/d (102.3 g/d and 73.5 g/d males and females respectively). The findings indicated that saturated fat (SF) contributed on average of all age groups for the two different genders approximately 36% of total fat intakes, provided approximately on average 14% and 12.8 % for males and females respectively of total daily energy intakes (see Table 5.4) and exceeded recommended values (10% of total daily energy intakes) (Department of Health, 1991; 2003). On the other hand, poly-unsaturated fat (PUFA) values for males and females were lower and close to the half of the values of adult British population. PUFA contributed on average of all age groups for the two different genders approximately 13% of total fat intakes (provided approximately on average 5.3% and 3.9% for males and females respectively of total daily energy intakes, see Table 5.4), which lower than the adult British population (30%). Thus, this sample population is consuming very high levels of fat for their age, especially saturated fat which is likely the way of cardiovascular disease and other health risks (Peter *et al.*, 2003).

Similarly, protein intakes were very high indeed (Table 5.4 and Figure 5.3) and reached 1.8 to 2.7 times (Table 5.5) the maximum daily requirement for similar age groups (Department of Health, 1991; 2003). The consumption of protein for subjects in current study aged 6 to 13 years on average equalled 84.8 g/d, where the total daily intake of proteins among British adults population is 74 g/d (84 g/d and 64 g/d for males and females respectively), with no significant difference between boys and girls. This very high intake of energy animal protein if combined with less performance of physical activity will lead to storage of protein as body fat and then will further add to weight gain (Fukagawa & Galbraith, 2004; Millward, 2004). At least two previous studies found a positive correlation between protein intake and BMI, suggesting increased intake of protein probably is the way of obesity (Alfieri *et al.*, 1997; Voss *et al.*, 1998). Furthermore, excessive intakes of protein contribute to deterioration of renal function in patients with renal disease or increasing glomerular filtration rate or endothelial dysfunction (Brenner *et al.*, 1982; Wiseman *et al.*, 1987; Garlick, 2004). Among sample population proteins contributed on average of all age groups for the two different genders approximately 16.4% of total daily energy intakes (approximately on average 15.3% and 17.2% for males and females respectively of total daily energy intakes), which were higher than the results obtained from the NHANES III study (14%) and also above COMA recommendations.

Carbohydrate intakes were also high compared to recommended values (Department of Health, 1991; 2003). The amount of carbohydrates that was consumed by subjects in the current study on average equalled 237.7 g/d which is close to consumption levels among British adults population (Department of Health, 1991; 2003), where the total daily intake of carbohydrate by the British population was 232 g/d (272 g/d and 193 g/d for males and females respectively). However, carbohydrates contributed on average of all age groups for the two different genders approximately 46% of total daily energy intakes (approximately on average 46.6% and 45.2% for males and females respectively of total daily energy intakes, see Figure 5.2 and Table 5.4), which were lower than the results obtained from the NHANES III study (53%) and also below the COMA recommendations (50%).

Therefore, the evidence in this study suggests that this is a largely sedentary sample population (the average of PAL ±SD was 1.29 ±0.13) and consuming high energy. There is no evidence to suggest that any concerted efforts are being made at the school or community level to improve the dietary habits and promote the physical activity of Kuwaiti school children. This emphasizes the need for an integrated approach to tackle the problem of obesity in Kuwait, with particular emphasis on children in the age group of 6 – 13 years old. As part of that integrated approach, the following diet and physical activity guidelines for this particular age group are suggested. Hopefully these guidelines, which were also revised by Department of Health (2003) and Neira & de Onis (2006), can be incorporated within diet and health framework of the Kuwait's Ministry of Health.

Diet and physical activity guidelines:

1. Carbohydrates should represent 50 to 55% of total daily energy intake.
2. Fats should not exceed 35% of total daily energy intake, and saturated fatty acids should be reduced to less than 10%.

3. Protein should provide a maximum of 15% of total daily energy intake, with the reduction of animal origin.
4. The daily consumption of vegetables and fruit should be increased to 5 portions (approximately 400 g/day).
5. Food products rich in sugars should be avoided or consumed moderately.
6. Drink plenty of water 1-2 litres/day.
7. Consume no more than 5 gram of salt per day.
8. Daily balanced breakfast, at home, is recommended (this can improve cognitive, and physical performances and decrease mid-morning craving effect).
9. Increase physical activity to at least 60 minutes of moderate-intensity activity five times a week.

In the next sections below, further evidence of the impact of the above findings on the individual child's physical characteristics and biochemical measures of risk will be highlighted. The combined effects of these findings as a cumulative exposure to nutritional and health risk will be discussed and a schematic model used to summarise their overall implications for public health.

8.4 Implications of current food-related behaviour and physical activity levels on body fatness and point prevalence of overweight and obesity

It is worth to reveal the prevalence of overweight and obesity in childhood, to predict early health risks. In sections 8.2 and 8.3 above, the translation of the effects of sedentary lifestyles, increased food intake, inappropriate food choices and their impact on estimated energy balance have been presented. Physical measures of obesity (i.e. using BMI and SFT cut-offs) have demonstrated a high prevalence of overweight and obesity in the sample population. This study indicates a high prevalence of total overweight of 57.2% based on SFT and of 65.5% based on BMI (Table 6.8). Of these overweight school children, approximately a half are obese, with a significant likelihood of some having multiple risk factors for diabetes II, heart disease, and a variety of other NCDs. It indicates that, there is an association of the occurrence of overweight with an improvement of Kuwaiti socio-economic status. This emphasizes that the high trend of obesity among

Kuwaiti children is due to environmental factors rather than genetics. This also agreed the findings of Florencio *et al.* (2001) who suggested that environment factors are likely to be responsible for the high prevalence of obesity. However, few studies have added puberty as a factor. For example, Irwin (1991) reported that body fat and lipids are all affected by puberty. In present study the percentage of body fat increased strikingly in females through adolescence, while it was not consistent in males (Table 6.4). In spite of that, such changes in body fat and lipid profiles during puberty may be influenced by the decrease in physical activity and changes in eating habits that are commonly seen during adolescence (Sallis *et al.*, 1992; Hill & Trowbridge, 1998).

Interestingly, there appears to be a discrepancy or lack of agreement between the two methods (BMI and SFT) in defining obesity among boys and girls, see Table 6.8 and Figure 6.13. Certainly, this is due to the use of varying criteria based on international data for defining obesity among local children. Previous study found different anthropometric indicators may give different indications for the same subjects (Dalton *et al.*, 2003). In spite of that, they have been widely used and were recommended for different populations (Lobstein *et al.*, 2004). Therefore, for precise health indications, Kuwait and other Arabian Peninsula countries should develop their own accepted references by using local data in order to determine which method is more accurate for measuring obesity among school-age children.

Further analysis of physical measures of nutritional risk when correlated with EI and PAR revealed interesting findings which have major health implications (Table 6.9). What these findings demonstrate is an apparent direct link between inappropriate food-related behaviour and lifestyle factors and physical inactivity which in my view are translated into changes in body composition. These are manifest in the changes in BMI, SFT and WHR observed in this sample population, which all are acting as a predictor not only of decreased physical activity level but additionally being strongly significantly linked to increased energy intake. In a recent study of age and sex-matched school-age children in Yemen, an Arab country, Raja'a *et al.*, (2001) reported ΣSFT values of males and females which were far less than those reported in this study. Such differences in ΣSFT values in two genetically similar populations suggest a possible strong environmental element to the differences because unlike Kuwait, Yemen is a relatively poor country and consequently, food availability, choices and dietary habits and nutrient intake among children in the two countries may have been significantly different.

The present scientific observations are also different from previously reported measures of physical characteristics of a similar cohort of school-age children growing up in Kuwait two decades earlier (Eid *et al*, 1984) (Figure 6.7). Essentially, this is a homogenous population whose genetic make-up has not changed significantly over the last two decades. What have changed significantly are environmental conditions relating to the epidemiological and nutrition transition in this population. These are reflected in the changes in income levels, wealth and the availability of a range of lifestyle choices which were not available to a similar population decades ago.

There is therefore a clear environmental element of concern regarding the risk factors which have been unravelled in this sample population namely: excess of energy intake over expenditure resulting from poor food choices, continuous physical inactivity, lack of nutrition education and lack of control in terms of school health policy and parental influence on children's nutrition-related behaviour. Once again, the policy implications of these observations are clear.

8.5 Evaluation of impact of obesity on biochemical indices of sample population (i.e. biochemical evidence for health and nutritional risk)

It is also well known that nutritional risk factors include biochemical and metabolic risks and that overweight and obesity predispose to the metabolic syndrome (Braunschweig *et al.*, 2005). Linking exposure to environmental risk factors to biochemical measures would help us understand further the extent to which risks have been translated into hazards and or whether they have been translated into clinical outcomes detrimental to health. These links with biochemical changes are the subject of this section.

8.5.1 Biochemical indices levels

Findings from pooled mean values of a number of biochemical indices of nutritional status suggest a well nourished sample population with most indices on the upper side of the normal range of reference values (Table 7.1). These values overall, were similar to biochemical values reported in well nourished populations elsewhere particularly in developed countries (Bartrina *et al.*, 2006). Further evaluation of these findings and their implications in the overall scheme of things follow in this discussion.

Although this proved to be an overfed population overall, it was found that approximately third of subjects (31.5% with Hb values below the reference range for age) also might be at risk of anaemia. These findings are consistent with that of Al-Mousa *et al.* (2003) who reported an overall mean haemoglobin level of 120 g/L (95% CI 73-159 g/L) among Kuwaiti school-age girls. The latter research group suggested that the low haemoglobin concentration was associated with poor dietary intake of haematinic nutrients, especially Fe and Folate sources. This observation is not entirely surprising given the range and types of foods chosen by this present cohort. There was over reliance on high fat sources, fizzy drinks and other high caloric foods with very little choice of green leafy vegetables and good iron source. The diets of this cohort also lacked fruits and vegetables which would have provided ascorbate to promote particularly the absorption of non-haem Fe in the diet. In a separate study on iron deficiency in overweight and obese children and adolescents in Israel, Pinhas-Hamiel *et al.* (2003) found that serum iron levels in the control group (normal children) was 15.8 (±5.6) μmol/L compared to lower values (13.3 ±5.5 μmol/L) in overweight children and even much lower levels in the obese children 10.6 (±5.7) μmol/L thus suggesting a link between obesity and risk of iron deficiency. In this study, the mean serum iron level of subjects was 13.11 (±4.67) μmol/L.

Compared to reference data, it is noteworthy that the mean (±SD) values for fasting glucose was equal 102.62 (±18.83) mg/dL were on the upper side of the normal range. This level among subjects was higher than the values reported by Weiss *et al.* (2004) for obese black, white, and Hispanic children in the United States and those by Alataki *et al.* (2004) for obese Greek children. Moreover, the mean glucose levels were higher than those reported by Brage *et al.* (2004) for Danish children.

There was a decreasing trend in the total cholesterol levels with age in the current study which is in agreement with the findings of El-Hazmi and Warsy (2001) for Saudi children of similar ages. The explanation for this observation is that dynamic changes in serum lipids tend to be observed during puberty (Fukushige *et al.*, 1996). Furthermore, serum HDL-cholesterol (HDL-c) values differed between males and females (p=0.005), but the pooled mean values of HDL-c were less than those reported by Sur *et al.* (2005) for Turkish age-matched school children.

A number of studies have attributed high levels of biochemical indices to changes in lifestyle and food habits (El-Hazmi and Warsy, 2001; Al Mousa *et al.*, 2003; Pinhas-Hamiel *et al.*, 2003; Brage *et al.*, 2004). In this study, the biochemical indices examined showed an upward trend compared to normal values in an age group which is relatively young. If these observations continue to persist, the chances are that these subjects will be vulnerable to diet-related NCDs. Of particular significance is the fact that overweight and obesity are known major risk factors for insulin resistance and type 2 diabetes mellitus (Haffner *et al.*, 1992; El-Hazmi & Warsy, 2001). Although these have in the past been regarded as diseases of older age-groups, the incidence is increasing among children, adolescents and young adults (Freedman *et al.*, 2002). Other co-morbidities related to obesity include abnormal lipid profiles, particularly high serum triacylglycerol levels, high LDL-cholesetrol and a low level of HDL-c (dyslipidaemias) plus insulin resistance and high blood pressure. These co-morbidities have collectively been classified as the components of the metabolic syndrome (syndrome X) (Ford and Giles, 2003; Das, 2005) with obesity at the centre of risk. It appears that the socio-demographic circumstances of this sample population have conspired to increase their vulnerability to obesity-related morbidity unless there is an effort to rectify or reverse the current trend.

8.5.2 Risk of metabolic syndrome

Present study identified the extent to which Kuwaiti school children are at risk of metabolic syndrome by analysing their blood sample for three risk factors: fasting glucose, HDL-c, and triglycerides. Although, the definition used for the metabolic syndrome was devised for older children (12 – 19 years), the literature showed that this definition have been used for younger children. In a study of obesity and risk factors for the metabolic syndrome among African-American school children (ages 8 – 12 years), Braunschweig *et al.* (2005) found that the metabolic syndrome occurred in 5.6% of participants, and exclusively in those with BMIs at or above the 95th percentile of NCHS reference values. Similarly, Weiss *et al.* (2004) reported that 49.7% of children (4 – 20 years old) with BMIs above the 97^{th} percentile (very obese) had the metabolic syndrome. Among our current study population 14.9% had three risk factors for the metabolic syndrome (Table 7.4) although we did not include measurement of blood pressure as one of the indicators. Insulin resistance was also not measured although serum fasting glucose levels showed an upward trend. There is a real risk of Type 2 diabetes and possibly cardiovascular risk in this population, which may not be directly the result of hereditary factors but rather environmental exposure variables. These clinical variables will be worth investigating further in the near future in order to ascertain their individual contributions to risk. However, the physical measurements together with our biochemical findings provide a picture of how childhood obesity among Kuwaiti school-age children might pose a serious clinical risk. This emphasizes the need for a school health policy including screening interventions and actual strategies including tackling physical activity programmes, school feeding and nutrition and health promotion plus appropriate counselling for those at increased risk.

8.6 Summary of possible public health and health promotion policy implications and interventions based on the findings of current study for the school-age population in Kuwait

This study has highlighted the underlying social changes that have led to rising levels of obesity in the particular age group 6 – 13 years old. These underlying factors, as listed below, are a consequence of social development and modernisation. Deep awareness of the impact of all of these determinants should be the core of any strategy targeting for the prevention of obesity or to reduce morbidity and mortality rates related to unhealthy diet and physical inactivity.

1. Depending on private transport for short distance; e.g. going to schools.

2. Low outdoor activity.
3. Less than one hour/day of moderate, intermittent activity.
4. Sleeping more than 8 hours a day.
5. Negative influence of friends and parents.
6. Negative impact of television, restaurants, and mass media advertisements.
7. Television viewing and playing stationary games more than one hour daily.
8. Conservative society, deprive girls from their preferable physical activity.
9. Skipping daily breakfast.
10. Eating without real need of food.
11. Eating without sitting at dinner place, and with no one to share.
12. Increased trend of fast food and sweetened soft drink consumption.
13. Low intake of fruit and vegetables.
14. Less energy intake derived from carbohydrates in comparison with fat and protein.

Figure 8.1 below summarises a conceptual framework of interacting variables which have informed this study and through which policies and interventions may be devised in order to tackle this public health challenge in the context of the Kuwaiti school-age population. The framework illustrates the impact of the socio-demographic transition that has occurred in Kuwait over the last three decades. This shows that as income levels have risen and people have continued to enjoy more comfortable lifestyles, there has been a direct effect on their levels of physical activity. This effect has been seen not only in the adult population who now own numerous vehicles per family, but more importantly, it is affecting children and adolescents. As other avenues for spending their time such as playing video games, watching television instead of doing household chores and outdoor activities, combined with a wider variety of food choices available to them new tastes and habits have been acquired.

The consequence of increased food availability and choice has been for young children to make choices which include high energy, high fat, sugar and salt based diets whilst at the same time, exhibiting low levels of daily total energy expenditure. This shift in energy balance has been confirmed in this study by the observation high BMI values, increased

ΣSFT, and increased WHR thus classifying the majority of subjects in this study as either overweight or obese.

Further evidence of the nutritional risk of the sample population is provided by clinical / biochemical measures including high levels of serum fasting glucose, total triacylglycerols and total cholesterol levels associated with low HDL-c levels. The latter further supports the notion that their levels of physical activity are low as this is associated with low HDL-c levels. These biochemical findings support the view that this sample population is at increased risk of NCDs and the metabolic syndrome.

Although the picture is one of a potentially serious public health epidemic, it also provides opportunities for action and the implementation of new policies and / or a review of existing policies in order to address the problem avert any public health crises and improve the health and well-being of the school-age child in Kuwait. The novelty of this project lies in how these exposure variables have been captured in order to paint a picture which allows for an intervention strategy to be developed and implemented.

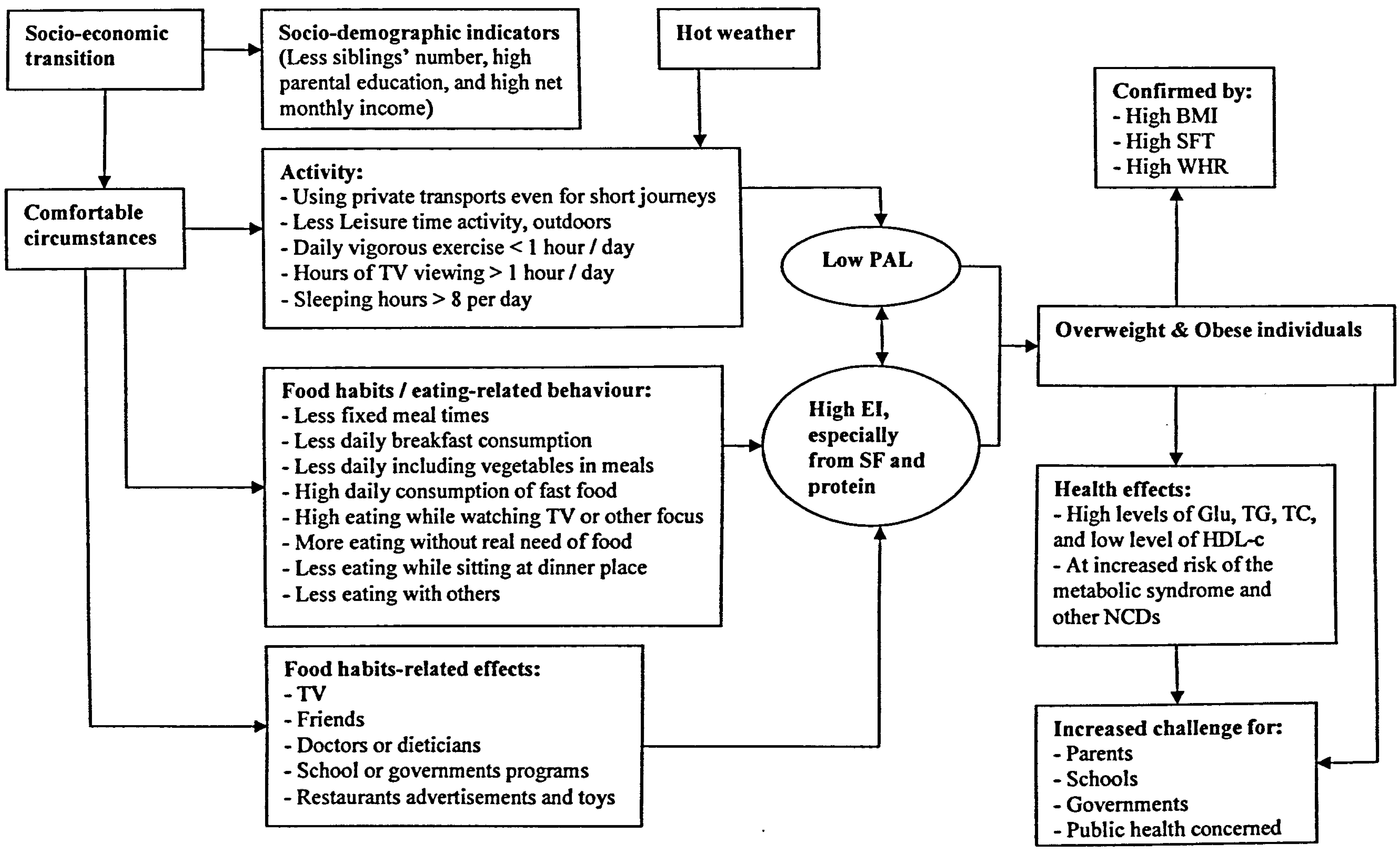


Figure 8.1 A conceptual framework for interactions of exposure variables and their implications for policy and interventions to reverse current childhood obesity trends and improve school health in Kuwait.

These findings, which have been outlined above, suggest the presence of risk of the NCDs associated with overweight and obesity and have serious health implications:

(1) to the individual in terms of their short, medium and long term risks;

(2) to the school community in terms of opportunities to review environmental risk factors and in particular nutrition education and health promotion, physical activity programmes and feeding practice within the school community;

(3) the family with regards to nutrition education and health promotion particularly in relation primary prevention of NCDs and lifestyle and dietary modification with a view to reducing overall calorie intake and promoting healthier lifestyles including fun-type physical activity for children;

(4) the public health authorities in terms of taking a serious look at these findings and ticking time bomb of obesity and NCD risk and their likely impact on the health of the nation, health costs and the economy;

(5) in the light of these serious findings to examine the policy implications and how through a multi-disciplinary approach, inter-agency working and strategies can be developed and implemented at the home (community) and school level to reverse the current trends.

Programmes specifically targeting the primary and secondary prevention of childhood obesity in Kuwait require work plans at different levels as follows:

A. Targeting the school community

- Physical education / activity programmes
- Nutrition education / health promotion
- School meals / feeding programme
- Involvement of school caterers and food suppliers

B. Targeting the school-age child

- Dietary and lifestyle modification programme
- Physical activity promotion
- Nutritional and psychological counselling

C. **Role of parents and local community**

- Parental education / support and involvement
- Parental control of lifestyle and food choices
- Parent-teacher cooperation / working together

D. **Role of government and policy makers**

- Review of current school health policies
- Undertake cost-benefit analyses relating to school health provision and the health of the nation
- Inter-agency policy working group between ministries of education, public health and local government
- Targeting and legislation regarding food advertising and working with the food industry
- Involvement of health professionals and other stakeholders

8.7 Examples of preventive strategies and its application to combat childhood obesity in Kuwait

The intense and rising burden of NCDs, considering the situation described above, necessitates the need for integrated approach to combat the problem of obesity in Kuwait. Medical treatment is expensive and due to current social and environmental pressures children are likely to remain seriously overweight and at risk of chronic diseases throughout their life (Summerbell *et al.*, 2003; Petrovici & Ritson, 2006). Thus, the high cost of such programmes (medical programmes) should be recommended only for the severe forms of obesity. A recent review of Lobstein *et al.* (2004) concluded that obesity prevention is the only feasible option for both developed and developing countries. It is the most realistic and cost effective approach for dealing with childhood obesity. Such programmes (obesity prevention) to promote a healthy diet and increased physical activity will benefit the health of all Kuwaiti school children, irrespective of obesity risk. However, these programmes require changes in social and environmental context, because children cannot be expected to bear the full burden of responsibility for preventing excess weight gain (Sjöström & Stockley, 2000; Ebbeling *et al.*, 2002; Kumanyika *et al.*, 2002).

The most important settings for preventive interventions are school and family-based settings. Schools influence the lives of most children and present frequent opportunities for education and promotion of healthy diets, physical activity and other healthy behaviours (Story, 1999). Nevertheless, most Kuwaiti schools did not encourage the choice of healthy food and/or physical activity. Only 10.3% of Kuwaiti school children interested in schools or government diet and health programmes (see Table 4.3). School syllabus should be modified in such a way to increase and reorient physical education by promote extracurricular physical activity as well as encourage choice of healthy food and drinks (e.g. schools should prohibit unhealthy food advertising). Schools also should persuade children to walk or go by cycle to school (92% of sample population daily reliance on private transport). On the other hand, at family setting, parents should take high levels of personal responsibility for their child health because this study has recognised a very minor effect of parents on their children (see section 8.2.3). As agents of change they could help their children to reduce weight. (Birch & Fisher, 1998; Fisher *et al.*, 2002; Klein-Platat *et al.*, 2003). However, obesity prevention is more likely to be effective and sustainable only if government policy and community structures encourage efforts undertaken by parents to achieve health-promoting environments for their children at home, and by education practitioners for teaching children about healthy diets and physical activity at schools (Campbell *et al.*, 2002). For this purpose, the prevention of obesity has been highlighted by different government agendas, such as USA (Institute of Medicine, 2004) and UK (www.dh.gov.uk; 2007). It is our view that the significant role of Kuwait government is to ensure that the health staff has a strong knowledge and awareness of the importance of overweight and obesity as a chronic condition that should receive similar interest as other NCDs. The Health Ministry should use all available opportunities to disseminate information on the dangers of obesity, and make clear training programmes for the staff. The Ministries of Health, Information and Education should organise frequent campaigns to promote physical activity and healthy eating. Further action is related to the regular detection of overweight and obesity using BMI, WHR, and SFT (at least two methods) should be part of the general check-up of all children, particularly school children, in schools as well as primary health care centres.

Currently only a few countries have developed comprehensive strategies (most have trials) to prevent the rising levels of obesity, although the prevalence of overweight is increasing worldwide. This section illustrates four examples of prevention programmes that have been tried and adopted by different countries. These examples can be useful for an intervention strategy to be developed and implemented to reverse current childhood obesity trends in Kuwait.

1) Trials by Robinson (1999; 2000) used a classroom curriculum to reduce television, videotape watching and video game playing among children aged 8 – 9 years (in grades 3 and 4) provided beneficial effects measured by different physical measurements. Intervention children group, who received 18 lessons over 7 months, watched significantly less television, videos and computer games when compared to the control group (similar aged children in a school of similar socio-demographic and academic status). This was complemented with a significant reduction in several physical measurements such as BMI, WHR, and SFT in the intervention group, although there was no difference in high-fat food intake. In regard to our study, high proportion of Kuwaiti school children spent several hours a day watching television (TV) and computer games. Consequently, suitable lessons relevant to this aspect may help to reduce weight gain. However, the action should not be ended at this point. The school plan should include other programmes that can promote diet (e.g. introducing adequate and balanced health meals) and physical activity (e.g. access to practical physical activity).

2) In Singapore, 'Trim and Fit', which is a national healthy lifestyle programme relate to school-age students has had some success in reducing the prevalence of obesity (Toh *et al.*, 2002). This programme includes a variety of changes in the school environment, backed up by resources from the Ministry of Education directed to the schools. The programme for overweight children consists of: "an exercise programme and counselling on proper nutrition. Teachers monitor the children's weight regularly. Physical activity takes the forms of games and exercises during recess or outside curriculum time. Parents of overweight children are invited to support the programme through seminars and meetings. Besides physical activities, overweight children are given nutrition counselling,

including choice of low-calorie foods in schools canteens. School canteen vendors are also advised on healthier methods of cooking. More fruit and vegetables are encouraged" (Singapore Ministry of Health, 2002).

Although, Education Ministry in Singapore supported this programme and provided intensive training for all teachers, 'Trim and Fit' achieved modest successes, with reduction in the prevalence of obesity from about 16% to 14% over an 8-year period. An important point that should be noted, the programme focused only on changes in the school environment and ignored other effects that related to the child outside school hours, such as the effects of brothers and sisters, friends, restaurant advertisements and mass media. These factors, plus the stigmatization factor (Wilson, 1994), are likely still affect eating and activity patterns of intervention children. This may help to explain the low degree of obesity prevention achieved by this programme. Nevertheless, similar programme targeting all school children (not only overweight and obese children or children at high risk for obesity) may help to reduce obesity among Kuwaiti school children if include intensive links with proper action plan at family and community, private sector and health system levels.

3) Crete, which is a Greek island, has one of the highest rates of childhood obesity documented for any population. A study of Mamalakis *et al.* (2000) has monitored a collection of children over a period of 6 years (1992-1998). Selected children were divided into two groups: intervention children group and control group. Twenty four schools participated in the intervention programme while twelve schools acting as controls. Interventions programme consist of: health education, improvements in nutrition and support to receive physical exercise (provided theoretically as a taught subject and practically as physical activity periods during school hours). A cohort of children aged about 6 years old was monitored in the first year of programme and again at age 9 and 12 years. The results compared with controls demonstrated significant improvement in the intervention children in terms of numerous cardiovascular risk factors (Manios *et al.*, 2002). Findings in terms of BMI also showed improvements in the intervention children compared with the control children. Among the three evaluation phases (at the outset,

mid-way and at the end of the trials), the greatest effects of the intervention appeared in the first 3 years. It is likely that older children have less attraction to school-based health messages. Therefore, the replication of such trials as a partial strategy for Kuwaiti school children may lead to adverse consequences after more than three years, with considering the times that spent by children outside schools. In addition, during this trial, there is no focal point to encourage significant change in the environment at home and community that possibly promote unhealthy behaviour.

4) In Spain, Ministry of Health and Consumer Affairs developed strategy for nutrition, physical activity and the prevention of obesity (NAOS). The aim of this strategy is to improve the diet and encourage the regular practice of physical activity by all citizens, with special emphasis on children and adolescents (Neira & de Onis, 2006). Over 80 organisations participated in drafting this strategy, including universities, professional colleges, scientific institutions, foundations and associations. The strategy launched on 10 February 2005 and focused on actions in four main levels: the family and community, the schools, the private sector, and the health system.

This strategy depends on the participation of professionals, parents, and consumer association in production and distribution of information promoting improved eating habits and active lifestyle (e.g. dietary and physical activity guidelines) at the family and community level, by using media campaigns, cartoons and other suitable symbols for this purpose. It also emphasizes the importance of creating green areas and sports facilities in neighbourhoods. In schools, policies and programmes that encourage healthy diets and physical activity are included in the academic curriculum knowledge and skills related to diet and nutrition. In order to get strategy in progress, voluntary agreements were signed between Spanish Ministry of Health and Consumer Affairs and the appropriate food and catering manufacturers in private sector to support healthy diets and physical activity. Finally, at health system level, the main action was to ensure that health professionals in Primary Health Care are aware of obesity as a chronic condition that should achieve the same concentration as other non-communicable diseases.

Certainly, Spanish strategy introduced practical solutions to reduce the trend of increasing obesity. Despite the environmental and cultural differences between the two countries (Kuwait and Spain), it includes useful suggestions for action that should be taken into consideration to support Kuwait strategy in order to promote a healthy diet and physical activity among school children. However, because it is new and started recently, there is a lack of evidence that support the efficacy of this strategy.

Although, there is a lack of evidence on the effectiveness of most proposed channels worldwide, a variety of channels (examples: mass media, written materials, skills training, counselling and advocacy) have been successfully employed by European countries (Sjöström & Stockley, 2000; Ells *et al.*, 2005). In regard to Kuwait, many approaches (channels) can be used targeting to promote a healthy diet and increased physical activity. For example, mass media can be useful at least for short term to promote running programmes and by introducing and supporting diet and physical activity guidelines (Grilli *et al.*, 1997). The participation of famous public personalities (e.g. sports men and women, famous actors, and comedian), parents and consumer association will be very useful to spread appropriate information on health issues to children (e.g. guide children on the detrimental effects of excess television watching and playing computer games). Healthy diets and active lifestyle also can be promoted by using cartoons and other representations of the entertainment industry. In addition, the input of health professionals to explain the role of nutrition in health promotion and prevention, as there is currently a lot of ignorance in term of this aspect in Kuwait. These suggestions for developing Kuwaiti public health strategy ultimately will depend on the Kuwaiti Ministry of Health that can use and tailor for suitable channels based on available facilities in order to make changes to encourage healthy lifestyle for Kuwaiti school children.

Overall, the beneficial outcomes of the first 3 examples are small compared with the size of obesity problem. Currently, there is limited quality data on the effectiveness of these strategies on long-term, perhaps, because obesity is a complex condition unlikely to be combated by relatively simple solutions. This means any programme (or solution) aimed at reducing or preventing the risk of obesity, in the medium-to-longer term, should be able to be evaluated periodically, sustainable, flexible and community acceptable. In the context of Kuwait, the combination of actions at family and community, schools, primary health services centres, with government support for the funding, monitoring and surveillance, is more important for obesity prevention and can achieve better results. In fact a strategy to prevent children from becoming obese is highly recommended to be taken into consideration, and then, launched as soon as possible, before it is too late, to decrease the risk of the heavy and growing burden of NCDs that are related to unhealthy diet and physical inactivity.

8.8 Strength and limitations of the current work

The strengths of the present study lie in the combining the following in one frame: i) the representative of the sample, ii) the investigation of socio-economic status, iii) the assessment of eating and activity-related behaviour, iv) the use of three accepted physical measurements (BMI, WHR, and SFT), and v) the estimation of metabolic syndrome risk factors. The analysis of the relationship between physical measurements and energy intake or physical activity ratio in school children (Table 6.9 and Figures 6.14 & 6.15), in addition to the analysis of metabolic syndrome components, makes this study one of the first in this field in Kuwait for the age group 6 – 13 year old. However, some possible limitations of this study have to be mentioned. Ideally it would have been useful to measure blood pressure and determine insulin resistance as part of the attempt to measure risk of the metabolic syndrome. This could form part of a future study in this population. In spite of this limitation, there is sufficient evidence to support the notion that risk of nutritional exposure exists in this population and needs urgent attention.

Another concern is the limited validity of measures of dietary intake and physical activity based on student reports. We cannot dismiss the possibility that the selected students may have biased their records of dietary intake and physical activity as a consequence of the survey, although we have no evidence to support this assumption. However, administered dietary and activity records for 7 days in this study possibly will minimises bias (Sempos *et al.*, 1992; Macdiarmid & Blundell, 1997). We have focused on 7-days dietary and activity records methods because it's accepted worldwide for this age group and there is no obvious data available from this method in the local region.

8.9 Conclusions

The epidemiological transition involving concurrent shifts in diet, physical activity and body composition is accelerating in Kuwait and associated with the prevalence of childhood obesity. This study highlights the high prevalence of overweight and obesity in 6 – 13 year old children in the primary and intermediate schools of Kuwait. Strong evidence indicates that the high intake of energy is not being offset by concomitant expenditure and then the prevalence of childhood obesity is increasing and if left unchecked this is likely to have some dire public health consequences.

The fast rising trends of overweight and obesity in a genetically homogeneous population, indicated that the environment factors actively support the promotion of fatness; and a summary of major evidences were as follows;

1. High level of socio-economic status has been accompanied by sedentary lifestyle and unhealthy food choice.
2. High energy intake and low physical activity level.
3. Adequate or high intake of micronutrients, it means subjects were well or over nourished although the micronutrients were not always absorbed by the body.
4. A consistent upward trend in weight, height, and BMI for the genetically homogenous population during the last two decades, in comparison to an earlier study of a similar age and sex-matched cohort by Eid *et al.* (1986) (Figure 6.7).
5. Most surveyed subjects were above the 90th centile of Magbool (1994) study (Saudi counterparts) although genetically similar, and then the suggestion of his study was rejected that the risk factor for obesity is mainly genetic.
6. In comparison with other previous studies, the values of BMI, WHR, and SFT tend to match similar values in wealthy rather than poor countries.
7. The three anthropometric measures (BMI, WHR, and SFT) were positively associated with daily energy intake and negatively associated with physical

activity ratio indicated that environmental factors play a major role in deriving obesity.

8. The fact that 14.9% of the study population had all the three risk factors for metabolic syndrome suggests a strong environmental influence on risks of obesity and its associated co-morbidities among Kuwaiti school-age children.

This study has clearly highlighted the presence of a significant public health problem i.e. increasing levels of childhood obesity in Kuwait. An attempt has been made not only to highlight the nature of the problem but also to provide a framework on interacting factors and how they relate to preventive strategies. A number of examples of studies and interventions undertaken elsewhere have been mentioned and an attempt made to suggest a strategy for tackling the problem in Kuwait. This study needs to be examined by policy makers in order to help them address the growing problem of childhood overweight and obesity in Kuwait.

References

Abalkhail B. Overweight and obesity among Saudi Arabian children and adolescents between 1994 and 2000. *Eastern Mediterranean Health Journal* 2002; 8(4&5).

Abalkhail B., and Shawky S. Comparison between body mass index, triceps skin fold thickness and mid-arm muscle circumference in Saudi adolescents. *Annals of Saudi Medicine* 2002; 22(5-6): 324-327.

Abdella N., Khogali M., Al-Ali S., Gumaa K., Bajaj J. known type 2 diabetes mellitus among the Kuwaiti population- A prevalence study. *Acta Diabetol* 1996; 33: 145-149.

Abernathy M., Fowler R. Micellar immprovement of the calmagite compleximetric measurment in plasma. *Clin Chem* 1982; 28 (3).

Ainsworth B.E., Haskell W.L., Leon A.S., Jacobs D.R.Jr., Montoye H.J., Sallis J.F., Paffenbarger R.S.Jr. Compendium of Physical Activities; classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise* 1993; 25 (1), 71-80.

Ainsworth, B.E., Haskell, W.L.,Whitt M.C., Irwin M.L., Swartz A. M., Strath S.J., O'Brien W.L.,Bassett D.R. Jr., Schmitz K.H., Emplaincourt P. O., Jacobs D.R.Jr., Leon A.S. Compendium of Physical Activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise* 2000; 32, S498-S516.

Alataki EP., Legbelou KP., Doukas L., Karatzidou K., Tsiontsi AP., and Pagkalos E. Clinical and biochemical manifestations of syndrome X in obese children. *Eur J Pediatr* 2004; 163: 573–579.

Alfieri M., Pomerleau J., and Grace, D. A comparison of fat intake of normal weight, moderately obese and severely obese subjects. *Obes. Surg.* 1997; 7: 9–15.

Al-Haddad F., Al-Nuaimi B. Little B., and Thabit M. Prevalence of obesity among school children in the United Arab Emirates. *Am. J. Hum. Biol.* 2000; 12:498-502.

Al-Haddad F., Little B., and Abdul Ghafoor A. Childhood obesity in United Arab Emirates schoolchildren: a national study. *Ann Hum Biol.* 2005; Jan-Feb;32(1):72-9.

AL-Isa A., and Moussa M. Obesity Among Kuwaiti Pre-School Children Aged 0-5 years: Prevalence and comparison With The NCHS/CDC Reverence Population. *Nutrition and Health* 1998;12:235-246.

Al-Isa A., and Moussa M. Nutritional status of Kuwaiti elementary school children aged 6-10 years: comparison with the NCHS/CDC reference population. *International Journal of Food Sciences and Nutrition* 2000; 51:221-228.

Al-Isa A. Body mass index and the level of fatness among Kuwaiti intermediate school adolescents aged 10-14 years. Health Sciences Center Poster Conference, Faculty of Medecine, Kuwait University, *Tenth Annual Health Science* 2005; April: 25-27.

Al-Isa A. Body mass index and prevalence of obesity changes among Kuwaitis. *Eur J Clin Nutr.* 1997;51:743–9.

Al-Isa A. Changes in body mass index and prevalence of obesity among Kuwaitis 1980-1994. *Int.J.Obes.Relat.Metab.Disord.* 1997; 21:1093-9.

Al-Isa A. Prevalence of obesity among adult Kuwaitis: a cross-sectional study. *International Journal of Obesity & Related Metabolic Disorders* 1995; 19: 431-433.

Al Khawari M., Shaltout A., Qabazard M., Abdella N., Al Moemen J., Al-Mazidi Z., Mandani F., and Moussa M. Incidence and severity of ketoacidosis in childhood-onset diabetes in Kuwait. *Diabetes Research and Clinical Practice* 1997; 35: 123-128.

Allain C., Poon L, Chen C., Richmond W., Fu PC. Enzymatic detrmination of total serum cholesterol. *Clin Chem* 1974; 20: 470-475.

Allison DB., Matz PE., Pietrobelli A., Zannolli R., and Faith MS. Genetic and environmental influences on obesity. In: Bendich A, Deckelbaum RJ (eds). *Primary and Secondary Preventive Nutrition.* Humana Press: Totowa, New Jersey, 1999, pp 147–164.

Allison DB., Paultre F., Poehlman ET., and Heymsfield SB. Statistical considerations regarding the use of ratios to adjust data. *Int J Obes Relat Metab Disord* 1995; 19:644-52.

Al-Mahroos F., and Al-Roomi K. Obesity among adult Bahrini population: Impact of physical activity and educational level. *Ann Saudi Med* 2001; 21(3-4):183-187.

Al-Mahroos FJ., and Al-Roomi KA. Overweight and obesity in the Arabian Peninsula: an overview. *J R Soc Health* 1999;119:251-3.

Al-Mannai A., Dickerson JW., Morgan JB., and Khalfan H. Obesity in Bahraini adults. *J.R.Soc.Health* 1996; 116:30-7.

Al Mousa Z., Prakash P., Jakson R., Al Raqua M. Acomparision of selected nutrient intakes in anemic and nonanemic adolescent girls in Kuwait. *Nutrition Research* 2003; 23: 425-433.

Al Mousa Z., and Parkash P. Prevalence of overweight and obesity among Kuwaiti children and adolescents. *Bahrain Medical Bulletin.* 2000; 22(3):123–7.

Al-Nuaim AR., Bamgboye EA., and Al Herbish A: The pattern of growth and obesity in Saudi Arabian male school children. *International Journal of Obesity.* 1996a; 20:1000-1005.

Al-Nuaim AR., Al-Rubeaan KA., Al-Mazrou Y., AlAttas O., Al-Daghari N., Khoja T. High prevalence of overweight and obesity in Saudi Arabia. *International Journal of Obesity & Related Metabolic Disorders* 1996b; 20: 547-552.

Al-Nuaim AR., Bamgboye EA., Al-Rubeaan KA., Al-Mazrou Y. Overweight and obesity in Saudi Arabian adult population: role of socio-demographic variables. *J.Community.Health* 1997; 22:211-23.

Alsaif M. A., Hakim I. A., Harris R. B., Alduwaihy M., Al-Rubeaan K., Al-Nuaim A. R. and Al-Attas O. S. Prevalence and risk factors of obesity and overweight in adult Saudi population. *Nutrition Research November* 2002; 22: 11, 1243-1252.

Al-Shammari H., Amuna P., Tewfik I., Bumejdad A., and Zotor F. Changing trends in physical characteristics and obesity risk in 6-13 year old Kuwaiti schoolchildren. Evidence of the nutritional and epidemiological transition. *Nutrition society summer meeting,* 3-6 July 2006. *Aberdeen, Scotland. Interactions between genetics, diet, health, and disease.*

Al-Shammari SA., Khoja TA., Al-Maatouq MA. High prevalence of clinical obesity among Saudi females: a prospective,cross-sectional study in the Riyadh region. *J Trop Med Hyg* 1994b;97:183-8.

Al-Shammari SA., Khoja TA., and Subaie AS. Transcultural attitude towards being overweight in patients attending health centers, Riyadh, Saudi Arabia. *Family Pract Res J.* 1994a;14: 149–56.

Amine EK., and Samy M. Obesity among female university students in the United Arab Emirates. *J R Soc Health.* 1996;116(2):91-6.

Aristimuno GG., Foster TA., Voors AW., Srinivasan SR., and Berenson GS. Influence of persistent obesity in children on cardiovascular risk factors: the Bogalusa Heart Study. *Circulation.* 1984; 69:895–904.

Armitage P., and Berry G. *Statistical methods in medical research,* 2nd ed. Oxford, Blackwell,1987.

Ashwell M., Cole TJ., and Dixon AK. Obesity: new insight into the anthropometric classification of fat distribution shown by computed tomography. *BMJ* 1985; 290:1692-4.

Assmann G., Schriewer H., Schmitz G., and Hagele E. *Clin Chem* 1983; 29:2026.

Azizi F. Tehran Lipid and Glucose Study. *Tehran: Endocrine Research Center*; 2001.

Barker DJP, ed. *Fetal and infant origins of adult disease.* London: *BMJ* Publishing, 1992.

Barker DJP., Gluckman PD., Godfrey KM., Harding JE., Owen JA., Robinson JS. Fetal nutrition and cardiovascular disease in adult life. *Lancet* 1993; 341: 938-41.

Barker DJP. Mothers, babies and disease in later life. London: *BMJ* Publishing, 1994.

Barker DJP. The developmental origins of adult disease. *European Journal of Epidemiology* 2003; 18, 733–736.

Bartrina JA., Serra-Majem L., Perez-Rodrigo C., Ribas-Barba L., and Delgado-Rubio A.Nutrition risk in the child and adolescent population of the Basque country: the enKid study. *British Journal of Nutrition* 2006; 96, Suppl. 1, S58-S66.

Baur LA., Ball EJ., O'Connor J., Steinbeck KS., Gaskin KJ., Wishart C., and Davies PSW. Physical activity, energy expenditure and body fatness in 6–8 year old children. *Int J Obes Relat Metab Disord* 2000; 24: S30.

Beaton GH. Approach to analysis of dietary data: Relationship between planned analyses and choice of methodology. *American Journal of Clinical Nutrition* 1994; 59 (suppl): 253S-261S.

Beckman Synchron CX7 Instruments Inc. Chemistry information Manaual – 12, 1996.

Bener A., Ziriel M., and Al-Rikabi A. Genetics, Obesity, and Environmental Risk Factors Associated with Type 2 Diabetes. *Croat Med J* 2005; 46(2):302-307.

Berenson GS., Srinivasan SR., Bao W., Newman WP III , Tracy RE., and Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. *N.Engl.J.Med.* 1998; 338:1650–6.

Berenson GS., Srinivasan SR., Cresanta JL., Foster TA., and Webber LS. Dynamic changes of serum lipoproteins in children during adolescence and sexual maturation. *Am J Epidemiol* 1981; 113:157–70.

Berkey CS., Rockett HR., Field AE., et al. Activity, dietary intake,and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics* 2000; 105: e56.

Binhemd T., Larbi EB., and Absood G. Obesity in primary health care centre: a retrospective study. *Ann Saudi Med* 1991; 11:163-6.

Birch LL., and Fisher JO. Development of Eating Behaviors Among Children and Adolescents. *Pediatrics* 1998;101 (3): 539-549.

Björntorp P. Etiology of the metabolic syndrome. In: Bray GA, Bouchard C, James WPT, eds. Handbook of obesity. 1st ed. New York: *Marcel Dekker, Inc,* 1998; 573-600.

Black AE. Critical evaluation off energy intake using the Goldberg cut-off for energy intake: basal metabolic rate. A practical guide to its calculation, use and limitations. *International Journal of Obesity* 2000; 24:1119-1130.

Borzekowski DL., and Robinson TN. The 30-second effect: an experiment revealing the impact of television commercials on food preferences of preschoolers. *J Am Diet Assoc* 2001; 101: 42–46.

Bowman SA., Gortmaker SL., Ebbeling CB., Pereira MA., and Ludwig DS. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* 2004; 113: 112–118.

Brage S., Wedderkopp N., Ekelund U., Franks PW., Wareham NJ., Andersen LB., and Froberg K. Features of the Metabolic Syndrome Are Associated With Objectively Measured Physical Activity and Fitness in Danish Children. The European Youth Heart Study (EYHS). *Diabetes Care* 2004; 27: 2141–2148.

Bray G. Finger points to corn syrup in obesity epidemic. *International Congress on Obesity* 2002. Sao Paulo (Brazil). [http://www.iotf.org/media/syrup.htm].

Brenner BM., Meyer TW., Hostetter TH. Dietary protein intake and progressive nature of kidney disease: The role of hemodynamically mediated glomerular injury in the pathogenesis of progressive gloomerular sclerosis in aging, renal ablatin, and intrinsic renal disease. *New Engl J Med* 1982; 307: 652-659.

Bucco G., and David H. Quantitative determination of serum triglycerides by the use of enzymes. *Clin Chem* 1973; 19: 476-482.

Bucolo G., David H. Quantitative determination of serum triglycerides by the use of enzymes. *Clin Chem* 1973; 19: 476-482.

Buzzard IM. Rational for an international conference series on dietary assessment methods. *American Journal of Clinical Nutrition* 1994; 59 (suppl): 143S-145S.

Byfield M., and Abuknesha R. Biochemical aspects of biosensors. Biosensors & Bioelectronics 1994; 9: 373-400.

Braunschweig C.L., Gomez S., Liang H., Tomey K., Doerfler B., Wang Y., Beebe C., and Lipton R. Obesity and risk factors for the metabolic syndrome among low-income, urban, African American schoolchildren: the rule rather than the exception. *American Journal of Clinical Nutrition* 2005; 81 (5): 970-975.

Campbell K., Waters E., O'Meara S., Kelly S., and Summerbell C. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2002; 2: CD001871.

Carey VJ., Walters EE., Colditz GA., Solomon CG., Willett WC., Rosner BA., Speizer FE., and Manson JE. Body fat distribution and risk of non-insulin-dependent diabetes mellitus in women. *Am J Epidemiol* 1997; 145:614-9.

Caroli M., Argentieri L., Cardone M., and Masi A. Role of television in childhood obesity prevention. *International Journal of Obesity and Related Metabolic Disorders* 2004; 28(supplement 3): S104–S108.

Chopra M., Galbraith S., and Darnton-Hill I. A global response to a global problem: the epidemic of overnutrition. Bull. *World Health Organ.* 2002; 80:952-958.

Clarke G.M. Statistics and Experimental Design. An Introduction for Biologists and Biochemists, *3rd ed., Edward Arnold*; 1993.

Colditz G., Willett W., Rotnitzky A., and Manson J. Weight gain as a risk factor for clinical diabetes mellitus in women. *Ann Intern Med* 1995; 122: 481–6.

Cole T., Bellizzi M., Plegal K., and Dietz W. Establishing standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; 320: 1-6.

Conway JM., Seale JL., Jacobs DR., Jr., Irwin ML., and Ainsworth BE. Comparison of energy expenditure estimates from doubly labeled water, a physical activity questionnaire, and physical activity records. *American Journal of m Clinical Nutrition* 2002; 75 (3): 519-525.

Cook S., Weitzman M., Auinger P., Nguyen M., and Dietz WH. Prevalence of a metabolic syndrome phenotype in adolescents. *Arch Pediatr Adolesc Med* 2003; 157:821-7.

Cornelius L. Health habits of school-age children. *Journal of health Care for the Poor and Underserved,* Winter 1991; 2:3, 374-395.

Dalton M., Cameron A.J., Zimmet P.Z., Shaw J.E. Jolley D., Dunstan D.W. & Welborn T.A. on behalf of the ausdiab steerng committee. Waist circumference, waist–hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. *Journal of Internal Medicine* 2003; 254: 555–563.

Danford LC., Schoeller DA., and Kushner RF. Comparison of two bioelectrical impedance analysis models for total body water measurement in children. *Ann Hum Biol.* 1996; 19:603-607.

Das U.N. Pathophysiology of metabolic syndrome X and its links to the perinatal period. *Nutrition* 2005; 21: 762–773.

Dehghan M., Akhtar-Danesh N., and Merchant AT.Childhood obesity, prevalence and prevention. *Nutrition Journal* 2005; 4:24.

Department of Health, Report on Health and Social Subjects. *41 Dietary Reference Values for Food Energy and Nutrients for the United Kingdom,* 1991 (12 impression 2003); Report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food policy (COMA).

Deurenberg P., Kusters CS., and Smit HE. Assessment of body composition by bioelectrical impedance in children and young adults is strongly age-dependent. *Eur J Clin Nutr.* 1990a; 44:261-268.

Deurenberg P., Pieters JJ., and Hautvast JG. The assessment of the body fat percentage by skinfold thickness measurements in childhood and young adolescence. *Br J Nutr* 1990b; 63:293-303.

Deurenberg P., van der KK., Paling A., and Withagen P. Assessment of body composition in 8-11 year old children by bioelectrical impedance. *Eur J Clin Nutr.* 1989; 43:623-629.

Dietz WH., and Robinson TN. Use of the body mass index as a measure of overweight in children and adolescents. *J Pediatr.* 1998; 132:191–3.

Dorosty AR., Siassi F., and Reilly JJ. Obesity in Iranian children. *Arch Dis Child.* 2002; 87: 388 – 391.

Ebbeling CB., Pawlak DB., and Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet* 2002; 360:473-482.

Eid N., Al-Hooti S., Bourisly N., and Khalafawi M. Nutritional anthropometry of school children in Kuwait. *Nutrion Reports International* 1986; 33:2, 253-260.

El-Hazmi M.A.F., and Warsy A.S. Association of hypertension and non-insulin-dependent diabetes mellitus in the Saudi population. *Ann Saudi Med* 2001; 21(1-2):5-8.

El-Hazmi M.A.F. and Warsy A.S. Prevalence of obesity in the Saudi population. *Ann Saudi Med* 1997; 17(3):302-306.

El-Hazmi,M.A.F., and Warsy A.S. The Prevalence of obesity in 1-18- year-old Saudi children. *Ann Saudi Med* 2002; 22(5-6):303-307.

Ells L., Campbell K., Lidstone J., Kelly S., Lang R., and Summerbell C. Prevention of childhood obesity. *Best Practice & Research Clinical Endocrinology & Metabolism* 2005; Vol. 19, No. 3, pp. 441–454. Available online at http://www.sciencedirect.com

Epstein LH., Paluch RA., Consalvi A., Riordan K., and Scholl T. Effects of manipulating sedentary behavior on physical activity and food intake. *J Pediatr* 2002; 140: 334–39.

Ferro-Luzzi A., and Martino L. Obesity and physical activity. *Ciba Found Symp.* 1996; 201:207-21; discussion 221-7.

Fisher J., Mitchell D., Smiciklas-Wright H., and Birch L. Parental influences on young girls' fruit and vegetable, micronutrient and fat intakes. Journal *of the American Dietetic Association* 2002; 102(1): 58–64.

Flegal KM., Harlan WR., and Landis JR. Secular trends in the United States, 1960-80 (letter). *Am J Epidemiol* 1990; 132:196-7.

Flood V., Webb K., Lazarus R., and Baur L. Recommendations for Monitoring Overweight and Obesity in NSW. NSW Food and Nutrition Monitoring project, The University of Sydney. NSW Department of Health, State Publication 2000; No (HP) 000028. For more information, this publication is available from the NSW HealthNet/Web. www.health.nsw.gov.au

Florencio TM., Ferreira HS., de Franca AP., Cavalcante JC., and Sawaya AL. Obesity and undernutrition in a very-low-income population in the city of Maceio, northeastern Brazil. *Br J Nutr* 2001; 86: 277–284.

Folsom AR., Stevens J., Schreiner PJ., and McGovern PG. Body mas index, waist/hip ratio, and coronary heart disease incidence in African Americans and whites. *Am J Epidemiol* 1998; 148:1187-94.

Ford ES., and Giles WH. A comparison of the prevalence of the metabolic syndrome using two proposed definitions. *Diabetes Care* 2003; 26:575–581.

Freedman DJ., Serdula MK., and Khan LK. The adult health consequences of childhood obesity. In: Chen C, Dietz WH (eds). *Obesity in Childhood and Adolescence.* Nestle Nutrition Workshop Series Pediatric Programme, v. 49. Lippincott Williams & Wilkins: Philadelphia 2002; pp 63–82.

Freedman DS., Dietz WH., Srinivasan SR., and Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics.* 1999; 103:1175–82.

Frisancho AR. Anthropemetric standards for assessment of growth and nutritional status. *Ann Arbor: University of Michigan Press* 1990.

Fukagawa N., and Galbraith R. Advancing Age and Other Factors Influencing th Balance between Amino Acid Requirements and Toxicity. *J. Nutr.* 2004; 134: 1569S-1574S.

Fukushige J., Igarashi H., Ueda K., Akazawa K., and Nose Y. Serum cholesterol levels in school-aged Japanese children: the Hisayama study. *Acta Paediatr Jpn.* 1996; 38(1): 22-7.

Gahagan S. Child and Adolescent Obesity. *Curr Probl Pediatr Adolesc Health Care* 2004; 34:6-43.

Gahagan S. Kindergarten children from single parent families more likely to be overweight [abstract]. *Pediatr Res* 2003; 41.

Garlick PJ. The Nature of Human Hazards Associated with Excessive Intake of Amino Acids. *J. Nutr.* 2004; 134: 1633S-1639S.

Gillman MW., Rifas-Shiman SL., Frazier AL. Family dinner and diet quality among older children and adolescents. *Archives of Family Medicine* 2000; 9(3): 235–240.

Goh VH., Tain C., Tong T., Mok H., and Wong M. Are BMI and other anthropometric measures appropriate as indices for obesity? A study in an Asian population. *J. Lipid Res* 2004; 45:1892–1898.

Goodrick GK., Poston WS., and Foreyt JP. Methods for voluntary weight loss and control: update. Nutrition 1996; 12:672-676.

Goran MI. Measurement issues related to studies of childhood obesity: assessment of body composition, body fat distribution, physical activity, and food intake. *Pediatrics.* 1998; 104:505–18.

Gray DS., Fujioka K., Colletti PM., and Kim H., Devine W., Cuyegkeng T., and Pappas T. Magneticresonance imaging used for determining fat distribution in obesity and diabetes. *Am J Clin Nutr*, 1991; 54:623-7.

Grilli R., Freemantle N., Minozzi S., Domenighetti G., and Finer D. Mass media interventions: effects on health services utilization. *Cochrane Review of Effectiveness*, 1997.

Grundy SM. Multifactorial causation of obesity: implications for prevention. *Am J Clin Nutr* 1998; 67:563S-572S.

Haffner SM., Valdez RA., Hazuda HP., Mitchell BD., Morales PA., and Stern MP. Prospective analysis of the insulinresistance syndrome (syndrome X). *Diabetes.* 1992; 41: 715–22.

Hales CN., Barker DJP. Type II (non-insulin-dependent) diabetes mellitus: the thrifty phenotype hypothesis. *Diabetologia* 1992; 35:595-601.

Hales CN. Fetal and infant growth and impaired glucose tolerance in adulthood. *Acta Paediatr Suppl.* 1997; 422:73–7.

Harding JE. The nutritional basis of the fetal origins of adult disease. *International Journal of Epidemiology* 2001; 30, 15–23.

Harrell J.S., McMurrary R.G., Baggett C.D., Pennell M.L., Pearce P.F., Bangdiwala S.I. Energy costs of physical activities in children and adolescents. *Medicine and Science in Sports and Exercise* 2005; 37(2), 329-336.

Harrison GG. Height-weight Tables. *Annals of Internal Medicine* 1985;103(Suppl 6, Pt 2):989–994.

Hartz AJ., Rupley DC., Kalkhoff RD., and Rimm AA. Relationship of obesity to diabetes: influence of obesity level and body fat distribution. *Prev Med* 1983; 12:351-7.

Hassan MO., and Al-Kharusy W. Physical fitness and fatness among Omani schoolboys: a pilot study. *SQU Journal for Scientific Rsearch: Medical Sciences* 2000; 2, 37–41.

Hernandez B., Gortmaker SL., Colditz GA., Peterson KE., Laird NM., and Para-Cabrera S. Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico City. *Int J Obesity* 1999; 23: 845–54.

Heyward VH., and Stolarczyk LM. Applied Body Composition Assessment, *Library of Congress Catalging-in-Publication Data*, USA, 1996.

Hicks C. R., *Fundamental Concepts in the Design of Experiments*, 3rd ed. USA: The Dryden Press, Saunders College Publishing; 1982.

Hill JO., and Peters JC. Environmental contributions to the obesity epidemic. *Science*. 1998; 280:1371-1374.

Hill JO., and Trowbridge FL. Childhood obesity: future directions and research priorities. *Pediatrics* 1998; 101:570–574.

Hitchings E. and Moynihan PJ. The relationship between television food advertisements recalled and actual foods consumed by children. *Journal of Human Nutrition and Dietetics* 1998; 11:511-517.

Hursti U. Factors influencing children's food choice. The Finish Medical Society Doudecim. *Ann Med* 1999; 31 (Suppl) 1: 26-32.

Hwallaa N., Sibaib AM., and Adrac N. Adolescent Obesity and Physical Activity. In Simopoulos AP (ed): Nutrition and Fitness: Obesity, the Metabolic Syndrome, Cardiovascular Disease and Cancer. *Basel, Karger*, 2005, vol 94, pp 42–50.

Institute of Medicine: Preventing Childhood Obesity: health in the balanc, 2004.

Irwin CE: Somatic growth and development during adolescence. In Pediatrics. Rudolph AM, Ed. East Norwalk, Conn., *Appleton & Lange*, 1991, p. 39.

James BS. Travel and health policy: what role could transport policies play in increasing physical activity? *Proc Pre-Olympic Congress* 2000, pp 33. [wwwtravelsmarttransportwagovau]

James W. & Schofield E. Human energy requirements: a manual for planners and nutritionists. New York: Oxford University Press 1990; 24: 91-101.

Jebb SA., Elia M. Techniques for the measurement of body composition: a practical guide. *Int J Obes Relat Metab Disord* 1993; 17:611-21.

Jequier E. Leptin signaling, adiposity, and energy balance. *Ann N Y Acad Sci.* 2002; 967:379-88.

Jeya C.K., Lightowler. H.J., and Al-Hourani, H.M. Physical Activity and Levels of Inactivity in Adolescent Females Ages 11–16 Years in the United Arab Emirates. *Am J Hum Biol* 2004; 16:346–353.

Kadish A.H., Little RL., and Strenberg JC. A new and rapid method for determination of glucose by measurment of rate oxygen consumption, *Clin Chem.* 144:116 (1968).

Kahn HS., Austin H., Williamson DF., and Arensberg D. Simple anthropometric indices associated with ischemic disease. *J Clin Epidemiol* 1996;49:1017–24.

Kain J., Uauy R., Vio F., and Albala C. Trends in overweight and obesity prevalence in Chilean children: comparison of three definitions. *Eur J Clin Nutr* 2002; 56: 200–204.

Kawate R., Yamakido M., and Nishimoto Y. Diabetes mellitus and its vascular complications in Japanese migrants on the Island of Hawaii. *Diabetes Care.* 1979; 29:161-170.

Kawate R., Yamakido M., and Nishimoto Y. Migrant studies among the Japanese in Hiroshima and Hawaii. *Proc 10th Congr Int Diabetes Federation.* 1980; 526-531.

Kerr D., and James J. Nutrition, physical activity, and obesity. *The Lancet* Oct 2002; 360: 1249.

Kimm S., and Obarzanek E. Childhood obesity: a new pandemic of the new millennium. *Pediatrics* 2002; 110:1003-1007.

Kiwanuka S.N., and Astrøm A.N. Self-reported dental pain and associated factors in Ugandan schoolchildren *Norsk Epidemiologi* 2005; 15 (2): 175-182.

Klein-Platat C., Wagner A., Haan. MC., Arveiler D., Schlienger JL., Simon C. Diabetes/Metabolism Research and Reviews: Prevalence and sociodemographic determinants of overweight in young French adolescents. *Diabetes Metab Res Rev* 2003;

19:153–158. For more information: Published online 28 February 2003 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/dmrr.368.

Klein S., Burke L., Bray G., Blair S ., Allison D., Pi-Sunyer X., Hong Y., and Eckel R. Clinical implications of obesity with specific focus on cardiovascular disease: a statement for professionals from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism, endorsed by the American College of Cardiology Foundation 2004; *Circulation* 110: 2952–2967.
Circulation is available at http://www.circulationaha.org

Kocaoglu B., Moschonis G., Dimitriou M., Kolotourou M., Keskin Y., Sur H., Hayran O., and Manios Y. Parental educational level and cardiovascular disease risk factors in schoolchildren in large urban areas of Turkey: Directions for public health policy. *BMC Public Health* 2005, 5:13.

Koçoglu G. Ozdemir L., Sümer H., Arzu Demir D., Cetinkaya S., and Hüseyin Polat H. Prevalence of Obesity among 11-14 Years Old Students in Sivas-Turkey. *Pakistan Journal of Nutrition* 2003; 2 (5): 292-295, 2003.

Koletzko B. Jean-Philippe Girardet, Klish W., and Tabacco O. Obesity in Children and Adolescents Worldwide: Current Views and Future Directions—Working Group Report of the First World Congress of Pediatric Gastroenterology, Hepatology, and Nutrition. *J Pediatr Gastroenterol Nutr* 2002; Vol. 35, Suppl. 2.

Kouda K., Nakamura H., WenYing Fan and Hiroichi Takeuchi. Negative relationships between growth in height and levels of cholesterol in puberty: a 3-year follow-up study. *International Journal of Epidemiology* 2003; 32: 1105–1110.

Krotkiewski M., Björntorp P., Sjöström .L, and Smith U. Impact of obesity on metabolism in men and women. Importance of regional adipose tissue distribution. *J Clin Invest* 1983; 72:1150-62.

Kuczmarski RJ., Ogden CL., Grummer-Strawn LM., Flegal KM., Guo SS, et al. CDC growth charts: United States. Advance data from vital and health statistics 2000; no. 314. Hyattsvill, MD: *Nationall Center for Health Statistics*. For more information see www.cdc.gov/growthcharts

Kumanyika S., Jeffery RW., Morabia A., Ritenbaugh C., Antipatis VJ. Public health approaches to the prevention of obesity. Working Group of the International Obesity TaskForce. Obesity prevention: the case for action. *Int J Obes* 2002; 26: 425– 436.

Kumanyika SK. Obesity in minority populations: An epidemiologic assessment. *Obes Res.* 1994; 2:166-182.

Lapidus L., Bengtsson C., Larsson B., Pennert K., Rybo E., and Sjöström L. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow up of participants in the population study of women in Gothenburg, Sweden. *BMJ* 1984; 289:1257-61.

Larsson B., Svärdsudd K., Welin L., Wilhelmsen L., Björntorp P., and Tibblin G. Abdominal adipose tissue distribution, obesity and risk of cardiovascular disease and death: 13 year follow-up of participants in the study of men born in 1913. *BMJ* 1984; 288:1401-4.

Laskarzewski P., Morrison JA., Mellies MJ., et al. Relationships of measurements of body mass to plasma lipoproteins in school children and adults. *Am J Epidemiol.* 1980; 111:395–406.

Lawlor DA., and Leon DA. Association of body mass index and obesity measured in early childhood with risk of coronary heart disease and stroke in middleage: findings from the Aberdeen children of the 1950s prospective cohort study. *Circulation* 2005; 111: 1891–1896.

Lazarus R., Baur L., Webb K., Blyth F., Gliksman M. Recommended body mass index cutoff values for overweight screening programmes in Australian children and adolescents: Comparisons with North American values. *J Paediatr Child Health.* 1995; 31: 143–147.

Lee R D., and Nieman D C., *Nutritional Assessment*, 3rd ed. New York: Mc Graw Hill Companies; 2003.

Lindsay RS., Dabelea D., Roumain J., Hanson RL., Bennett PH., Knowler WC. Type 2 diabetes and low birth weight: the role of paternal inheritance in the association of low birth weight and diabetes. *Diabetes* 2000; 49: 445–49a.

Lindsay RS., Hanson RL., Bennett PH., Knowler WC. Secular trends in birth weight, BMI, and diabetes in the offspring of diabetic mothers. *Diabetes Care* 2000; 23:1249–1254b.

Lin B., Guthrie J., and Frazao E: "Nutrient Contribution of Food Away from Home." Washington, DC: Economic Research Services, *US Dept of Agriculture* 1999; pp 231–242.

Link K., Moell C., Garwicz S., Cavallin-Stahl E., Bjork J., Thilen U., Ahren B., and Erfurth EM. Growth hormone deficiency predicts cardiovascular risk in young adults treated for acute lymphoblastic leukemia in childhood. *J Clin Endocrinol Metab* 2004; 89:5003-5012.

Lissau I., and Sorensen TIA. Prospective study of influence of social factors in childhood on risk of overweight in young adulthood. *Int J Obes* 1992; 16: 169-175.

Lissner L., Björkelund C., Heitmann BL., Lapidus L., Bjőrntorp P., and Bengtsson C. Secular increases in waist-hip ratio among Swedish women. *Int J Obes Relat Metab Disord* 1998;22:1116–20.

Lobstein T., Baur L., and Uauy R. Obesity in children and young people: a crisis in public health. *Obesity reviews* 2004; 5 (Suppl. 1): 4–104.

Lohman T. The use of skinfolds to estimate body fatness on children and youth. *Journal of Physical Education, Recreation, and Dance* 1987; 58 (9):98-102.

Lohman T., Roche A., and Mastorell R. *Anthropometric standardization reference manual.* Champaign (IL): Human Kinetics, 1991.

Lucas, A., Fewtrell, M. S., Cole, T. J. Fetal origins of adult disease the hypothesis revisited. *Br Med J.* 1999; 319: 245–249.

Lucas A., Morley R., Cole TJ., Bamford MF., Boon A., Crowle P., Dossetor JFB., Pearse R. Maternal fatness and viability of preterm infants. *Br Med J* 1998; 296: 1495 – 1497.

Lucas A. Programming by early nutrition in man. In: Bock GR, Whelan J, eds. *The Childhood Environment and Adult Disease* (Ciba Foundation Symposium 156). Chichester, UK: Wiley; 1991, pp. 38–55.

Lukaski H. Methods for the assessment of human body composition: traditional and new. *American Journal of Clinical Nutrition* 1987; 46:537–556.

Macdiarmid JI., Blundell JE. Dietary underreporting: what people say about recording their food intake. *European Journal of Clinical Nutrition* 1997; 51: 199-200.

Maffeis C., Corciulo N., Livieri C., Rabbone I., Trifiro G., Falorni A., Guerraggio L., Peverelli P., Cuccarolo G., Bergamaschi G., Di Pietro M., and Grezzani A. Waist circumference as a predictor of cardiovascular and metabolic risk factors in obese girls. *Eur. J. Clin. Nutr.* 2003; 57, 566–572.

Maffeis C., Micciolo R., Must A., Zaffanello M., and Pinelli L. Parental and perinatal factors associated with childhood obesity in north-east Italy. *Int J Obes* 1994; 18: 301-305.

Maffeis C., Pinelli L., and Schutz Y. Fat intake and adiposity in 8–11 year old obese children. *Int J Obes Relat Metab Disord* 1996;20:170–4.

Magbool G. Body Mass Index of Saudi Children Ages six to 16 Years From the Eastern Province, *Ann Saudi Med* 1994; 14:495-8.

Malekzadeh R., Mohamadnejad M., Merat S., Pourshams A., and Etemadi A. Obesity Pandemic: An Iranian perspective. *Archives of Iranian Medicine* 2005; 8(1): 1-7.

Mamalakis G., Kafatos A., Manios Y., Anagnostopoulou T., and Apostolaki I. Obesity indices in a cohort of primary school children in Crete: a six year prospective study. *Int J Obes* 2000; 24: 765–771.

Mamalakis G., Kafatos A., Manios Y., Kalogeropoulos N., and Andrikopoulos N. Adipose Fat Quality vs Quantity: Relationships with Children's Serum Lipid Levels. *Preventive Medicine* 2001; 33: 525–535. For more information, available online at http://www.idealibrary.com

Manios Y., Moschandreas J., Hatzis C., and Kafatos A. Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6-year intervention programme. *Br J Nutr* 2002; 88: 315–324.

Martorell R., Stein A D., and Schroeder D G. Symposium: Obesity in Developing Countries: Biological and Ecological Factors. Early Nutrition and Later Adiposity. *American Society for Nutritional Sciences. The Journal of Nutrition* 2001; 131: 874S–880S.

Mason R. L., Gunst R. F., and Hess J. L., Statistical Design and analysis of Experiments, with Applications to Engineering and Science, *2nd ed., New York: John Wiley & Sons;* 2003.

McDowell MA., Briefel RR., Alamino K., Bischof AM., Caughman CR., Carroll MD., Loria CM., and Johnson CL. Energy and Macronutrient intakes of persons ages 2 months and over in the United States: Third National Health and Nutrition Examination Survey, phase 1, 1988-91. *Avance Data from vital and Health Statistics.* 1994; No.225. Hyttsvill, MD: National Center for Health Statistics.

MacIntyre UE., Venter CS., Vorster HH. A culture-sensitive quantitative food frequency questionnaire used in an African population: 2. Relative validation by 7-day weighted records and biomarkers. *Public Health Nutr* 2004; 4: 63-71.

Megnien JL., Denarie N., Cocaul M., Simon A., and Levenson J. Predictive value of waist-to-hip ratio on cardiovascular risk events. *Int J Obes Relat Metab Disord* 1999; 23:90-7.

Mela D. Symposium on 'Functionality of nutrients and behaviour'- Food choice and intake: the human factor. *Proceedings of the Nutrition Society* 1999, 58:513-521.

Metges CC., and Barth CA. Metabolic Consequences of a High Dietary-Protein Intake in Adulthood: Assessment of the Available Evidence. *American Society for Nutritional Sciences J. Nutr.* 2000; 130:886–889.

Mickey R M., Dunn O J., and Clark V A. Applied Statistics: Analysis of Variance and Regression, *3rd ed., New York: John Wiley & Sons*; 2004.

Millward D. J. Macronutrient Intakes as Determinants of Dietary Protein and Amino Acid Adequacy. *J. Nutr.* 2004; 134: 1588S-1596S.

Ministry of Education. Statistical Data of Education In the State of Kuwait For the Scholastic Year 2001/2002 (in Arabic), Planning Department, State of Kuwait, 1 (2001).

Molarius A. and , Seidell JC. Selection of anthropometric indicators for classification of abdominal fatness -a critical review. *Int J Obes Relat Metab Disord* 1998; 22:719-27.

Montague CT., Farooqi IS., Whitehead JP., et al. Congenital leptin deficiency is associated with severe early-onset obesity in humans. *Nature* 1997; 387: 903–08.

Moussa M., Shaltout A., Nkansa D., Mourad M., AlSheikh N., Agha N., Galal D. Factors associated with obesity in Kuwaiti children. *European Journal of Epidemiology* 1999; 15: 41-49.

Morrison B. Use of the Beckman glucose analyzer for low and high glucose values. *Clin Chem Acta* 1972; 42:192.

Moussa W.A. Two decades of nutrition assessment in the Eastern Mediterranean Region: scope, methodologies and dissemination. *Eastern Mediterranean Health Journal.* 2004; 10(6) 704-715.

Musaiger AO. Overweight and obesity in the Eastern Mediterranean Region: can we control it? *Eastern Mediterranean Health Journal* 2004; 10 (6): 789-793.

Must A., Spadano J., Coakley EH., Field AE., Colditz G., DietzWH. The disease burden associated with overweight and obesity. *Journal of the American Medicine Association* 1999; 282: 1523-1529.

Nasser M. Comparative study of the prevalence of abnormal eating attitudes among Arab female students of both London and Cairo universities. *Psychol Med.* 1986; 16:621–5.

Nassis GP., Psarra G., and Sidossis LS. Central and total adiposity are lower in overweight and obese children with high cardiorespiratory fitness. *European Journal of Clinical Nutrition* 2005; 59, 137–141.

National Task Force on the Prevention and Treatment of Obesity. Overweight, obesity, and health risk. *Archives of Internal Mediciine* 2000; 160: 898-904.

NCHS – 2000 CDC Growth Charts Website:
http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm
Nutritional Assessment Website: www.mhhe.com/hper/nutrition

Neira M., and de Onis M. The Spanish strategy for nutrition, physical activity and the prevention of obesity. *British Journal of Nutrition* 2006; 96, Suppl. 1, S8-S11.

Nestle M. Editorial: the ironic politics of obesity. *Science*, 2003; 299:781.

Newell A., Zlot A., Silvey K., Ariail K. Addressing the Obesity Epidemic: A Genomics Perspective. *Preventive chronic disease. Public health research, practice and policy* 2007; volume 4: No 2. www.cdc.gov/pcd/issues/2007/apr/06_0068.htm. Centers for Disease Control and Prevention

NHMRC, National Health and Medical Research Council. Draft national clinical guidelines for weight control and obesity management in children and adolescents. Canberra: NHMRC, 2002.

Nguyen VT., Larson DE., Johnson RK., and Goran MI. Fat intake and adiposity in children of lean and obese parents. *Am J Clin Nutr* 1996;63:507–13.

NIH, National Institute of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. National Heart, Lung, and Blood Institute. *NIH publication number* 1998; 98-4083.

NIHCM. Childhood Obesity – Advancing Effective Prevention and Treatment: An Overview for Health Professionals. Issue Paper. *National Institute for Health Care Managment, Research and Educational Foundation* 2003; Washington D.C.
For more information: www.nihcm.org

Obarzanek E. Methodological issues in estimating the prevalence of obesity in childhood. *Ann N Y Acad Sci.* 1993; 699:278–9.

Obarzanek E., Schreiber GB., and Crawford PB. Energy intake and physical activity in relation to indexes of body fat: the National Heart, Lung, and Blood Institute Growth and Health Study. *Am J Clin Nutr* 1994;60:15–22.

Ofcom. Childhood Obesity-Food Advertising in Context. Children's food choices, parent's understanding and influence, and the role of food promotion. *The Office of Communications*. July 2004.

Paccaud F., Schlüter-Fasmeyer V., Wietlisbach V., and Bovet P. Dyslipidemia and abdominal obesity: an assessment in three general populations. *Journal of Clinical Epidemiology* 2000; 53: 393–400.

Parsons TJ., Power C., Logan S. & Summerbell CD. Childhood predictors of adult obesity: a systematic review. *International Journal of Obesity and Related Metabolic Disorders* 1999; 23(supplement 8): S1–107.

Peter T., Katzmarzyk, Tremblay A., Perusse L., Depres JP., and Bouchard C. The utility of the international child and adolescent overweight guidelines for predicting coronary heart disease risk factor. *Journal of Clinical Epidemiology*, May 2003; 56 : 456-462.

Petrovici D., and Ritson C. Factors influencing consumer dietary health preventative behaviours. *BMC Public Health* 2006; 6:222. http://www.biomedcentral.com/1471-2458/6/222.

Pietrobelli A., Faith MS., Allison DB., Gallagher D., Chiumello G., and Heymsfield SB. Body mass index as a measure of overweight in children and adolescents. *J Pediatr.* 1998; 132:204–10.

Pinhas-Hamiel O, Newfield RS, Koren I, Agmon A, Lilos P., and Phillip M. Greater prevalence of iron deficiency in overweight and obese children and adolescents. *International Journal of Obesity* 2003; 27: 416–418.

Phillips SM., Bandini LG., Compton DV., Naumova EN., and Must A. A longitudinal comparison of body composition by total body water and bioelectrical impedance in adolescent girls. *Journal of Nutrition.* 2003; 133:1419-1425.

Pollard T., Steptoe A., and Wardle J. Motives underlying healthy eating: using the food choice questionnaire to explain variation in dietary intake. *J. biosoc. Sci.* 1998; 30:165-179.

Popkin BM., and Udry JR. Adolescent obesity increases signifi-cantly in second and thrid generation US immigrants: the NationalLongitudinal Study of Adolescent Health. *J Nutr* 1998; 128: 701–706.

Poulsen P., Vaag A., Kyrik K., Moller-Jensen D., Beck-Nielsen H. Low birth weight is associated with NIDDM in discordant monozygotic and dizygotic twin pairs. *Diabetologia* 1997; 40,439-446.

Potvin L., Desrosiers S., Trifonopoulos M., Leduc N., Rivard M., Macaulay A., and Paradis G. Anthropometric characteristics of Mohowk children aged 6 to 11 years: A population perspective. *Journal of The American Dietetic Association* 1999; 99: 955-961.

Prentice A. Obesity and its potential mechanistic basis. In type 2 diabetes: the thrifty phenotype. *British Medical Bulletin* 2001; 60, 51–67.

Raja'a, Y., and Mohanna M. Overweight and Obesity among School children in Sana'a City, Yemen. *Ann Nutr Metab* 2005; 49:342 –345.

Raja'a Y., Sulaiman SM., Elkarib SA., and Mubarak JS. Nutritional status of Yemeni schoolchildren in Al-Mahweet Governorate. *Eastern Mediterranean Health Journal* 2001; 7(1/2):204-210.

Rankinen T., Kim S-Y., Pérusse L., Després J-P., and Bouchard C. The prediction of abdominal visceral fat level from body composition and anthropometry: ROC analysis. *Int J Obes Relat Metab Disord* 1999; 23:801-9.

Ravussin E., Valencia ME., Esparza J., Bennett PH., and Schultz LO. Effects of a traditional lifestyle on obesity in Pima Indians. *Diabetes Care.* 1994; 17:1067-1074.

Renders CM., Seidell JC., van Mechelen W., Hirasing RA. Overweight and obesity in children and adolescents and preventative measures (in Dutch). *Ned Tijdschr Geneeskd* 2004; 148: 2066–2070.

Robinson TN. Can a school-based intervention to reduce television use decrease adiposity in children in grades 3 and 4? *West J Med* 2000; 173: 40.

Robinson TN. Does television cause childhood obesity? *JAMA* 1998; 279: 959–60.

Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *JAMA* 1999; 282: 1561–1567.

Rolland-Cachera MF., Deheeger M., Akrout M., and Bellisle F. Influence of macronutrients on adiposity development: a follow up study of nutrition and growth from 10 months to 8 years of age. *Int J Obes Relat Metab Disord.* 1995; 19(8):573-8.

Ronnemaa T., Knip M., Lautala P., et al. Serum insulin and other cardiovascular risk indicators in children, adolescents and young adults. *Ann Med.* 1991; 23:67–72.

Saelens BE., Sallis JF., Nader PR. Home environmental influences on children's television watching from early to middle childhood. *Journal of Developmental and Behavioral Pediatrics* 2002; 23(3): 127–132.

Sallis JF., Simons-Morton BG., Stone EJ., Corbin CB., Epstein LH., Faucette N., Iannotti RJ., Killen JD., Klesges RC., and Petray CK. Determinants of physical activity and interventions in youth. *Med Sci Sports Exerc* 1992; 24:S248–S257

Saleh EA., Mahfouz AA., Tayel KY., Naguib MK., and Bin- al- Sheikh NM. Hypertension and its determinants among primary-schoolchildren in Kuwait: an epidemiology study. *East Mediterr Health J.* 2000; 6: 333-337.

Saris WH., Blair SN., van Baak MA., Eaton SB., Davies PS., Di Pietro L., Fogelholm M., Rissanen A., Schoeller D., Swinburn B., Tremblay A., Westerterp KR., and Wyatt H. How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obesity Reviews* 2003; 4:101–114.

Sawaya W., Al-awadi F., Eid N., and Dashti B. Food Composition, Kuwaiti Composite Dishes, 1st edition, Kuwait *Institute For Scientific Research (KISR)*, Kuwait, Press, 1998.

Schofield W., Schofield C., and James W. Basal metabolic rate-review and prediction. *Hum Nutr* 1985; 39 (suppl): 1-96.

Schroder H., Covas MI., Marrugat J., Vila J., Pena A., Alcantara M. Use of a three-day estimated food record, a 72-hour recall and a food frequency questionnaire for dietary assessment in a Mediterranean Spanish population. *Clin Nutr* 2001; 20: 429-37.

Seidell JC., and Bouchard C. Visceral fat in relation to health: is it a major culprit or simply an innocent bystander? *Int J Obes Relat Metab Disord* 1997; 21:626-31.

Seidell JC., Oosterlee A., Deurenberg P., Hautvast JGAJ., and Ruijs JHJ. Abdominal fat depots measured with computed tomography: effects of degree of obesity, sex and age. *Eur J Clin Nutr* 1988; 42:805-15.

Seidell JC., Oosterlee A., Thijssen MA., Burema J., Deurenberg P., Hautvast JG., and Ruijs JH. Assessment of intra-abdominal and subcutaneous abdominal fat: Relation between anthropometry and computed tomography. *Am J Clin Nutr* 1987; 45:7-13.

Seidell JC., Han TS., Feskens EJM., and Lean MEJ. Narrow hips and broad waist circumferences independently contribute to increased risk of non-insulin-dependent diabetes mellitus. *J Intern Med* 1997; 242:401-6.

Seidell JC., Kahn HS., Williamson DF., Lissner L., and Valdez R. Report from a Centers for Disease Control and Prevention Workshop on use of adult anthropometry for public health and primary health care. *Am J Clin Nutr* 2001; 73:123-6.

Seidell JC. The impact of obesity on health status: Some implications for health care costs. *Int.J.Obes.Relat.Metab.Disord.* 1995; 19:S13-6.

Sempos CT., Briefel RR., Johnson C., and Woteki CE. Process and rationale for selecting dietary methods for NHANES III. In National center for Health Statistics. *Dietary methodology workshop for the Third National Health and Nutrition Examination Survey* 1992; Hyattsville, MD: U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control.

Serra-Majem L., Bartina J., Perez-Rodrigo C., Ribas-Barba L., and Delgado-Rubio A. prevalence and determinants of obesity in Spanish children and young people. British *Journal of Nutrition.* 2006; 96, Suppl. 1, S67-S72.

Sibai A.M., Hwalla N., Adra N., and Rahal B. Prevalence and Covariates of Obesity in Lebanon: Findings from the First Epidemiological Study. *OBbesity Research* 2003a; 11 (11): 1353-1361.

Sibai AM., Kanaan N., Chaaya M., Rahal B., Abdullah A., and Sibai T. Ethnic differences in weight loss behavior among secondary school students in Beirut: the role of weight perception. Soz Praventivmed. 2003b;48:234–41.

Singapore Ministry of Health. *The State of Health 2001. The Report of the Director of Medical Services Singapore.* Ministry of Health: Singapore, 2002; p 35, [http://www.moh.gov.sg/newmoh/ pdf/pub/health_report.pdf].

Sinha R., Fisch G., Teague B., Tamborlane WV., Banyas B., Allen K., et al. Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. *New Engl J Med* 2002; 346:802-10.

Sjöström M., and Stockley L. Toward Public Health Nutrition Strategies in the European Union to implement Food Based Dietary Guidelines and to enhance healthier lifestyles. *Eurodiet Reports*: 3, 2000; http://eurodiet.med.uoc.gr/

Smithers G., Gregory JR., Bates CJ., Prentice A., Jackson LV., and Wenlock R. Review, The national Diet and Nutrition Survey: young people aged 4-18 years. *British nutrition Foundation Nutrtion Bulletin* 2000; 25:105-111.

Smoak CG., Burke GL., Webber LS., Harsha DW., Srinivasan SR., and Berenson GS. Relation of obesity to clustering of cardiovascular disease risk factors in children and young adults: the Bogalusa Heart Study. *Am J Epidemiol.* 1987; 125:364–72.

Sobal J., and Stunkard AJ. Socioeconomic status and obesity: A review of the literature. *Psychol Bull.* 1989; 105:260-275.

Steinbeck K. The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. The International Association for the Study of Obesity. *obesity reviews* 2001; 2: 117–130.

Steptoe A., Pollard T., and Wardle J. The development of a measure of the motives underlying the selection of food: the Food Choice Questionnaire. *Appetite* 1995; 25: 267-284.

Story M. School-based approaches for preventing and treating obesity. *International Journal of Obesity and Related Metabolic Disorders* 1999; 23(supplement 2): S43–S51.

St-Onge MP., Keller KL., and Heymsfield SB. Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights. *Am J Clin Nutr* 2003; 78:1068–1073.

STOPP-T2D Collaborative Group. Obesity, diabetes and the metabolic syndrome in 8th grade children. *Diabetes* 2004; 53:S2;A7.

Styne DM. Obesity in childhood: what's activity got to do with it? *American Journal of Clinical Nutrition* 2005; 81:337-338.

Summerbell C., Ashton V., Campbell K, Edmunds L., Kelly S., and Waters E. Interventions for treating obesity in children. *Cochrane Database Systematic Review* 2003; 3: CD001872.

Sur H., Kolotourou M., Dimitriou M., Kocaoglu B., Keskin Y., Hayran O., and Manios Y. Biochemical and behavioral indices related to BMI in schoolchildren in urban Turkey. *Preventive Medicine* 2005; 41: 614–621.

Suàrez-Herrera J. Community nutrition programmes, globalization and sustainable development. *British Journal of Nutrition* 2006; 96, Suppl. 1, S23-S27.

Sysmex SF-3000 Operator's Manual – Revised September 1995.
For more information, website: http://www.labx.com
Sysmex, 2002 website:
http://www.sysmex.com/usa/ourproducts/our_products_detail.cfm?p_id=42

Taras HL., and Gage M. Advertised foods on children's television. *Arch Pediatr Adolesc Med* 1995; 149: 649–652.

Tataranni Arline D. Salbe T., Weyer C., Lindsay R., Ravussin E., Antonio P. Assessing Risk Factors for Obesity Between Childhood and Adolescence: I. Birth Weight, Childhood Adiposity, Parental Obesity, Insulin, and Leptin. *Pediatrics* 2000; vol. 110 No. 2.

Thompson D., Wolf AM. The medical-care cost burden of obesity. *Obesity Review* 2001;2:189-97.

Toh CM., Cutter J., and Chew SK. School based intervention hasreduced obesity in Singapore. *BMJ* 2002; 324: 427.

Torun B., Davies PSW., Livingstone MBE, Paolisso M., Sackett R., Spurr GB (with contribution from de Guzman MPE.). Energy requirements and dietary energy recommendations for children and adolescents 1 to 18 years old. *European Journal of Clinical Nutrition*, February 1996; Volume 50, Supplement 1.

Torun B: Energy cost of various physical activities in healthy children. In: *Activity, energy expenditure and energy requirements of infants and children*, eds Schürch B & Scrimshaw NS, 1990, pp 139-183. Lausanne: International Dietary Energy Consultancy Group.

Vague J. The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. *Am J Clin Nutr* 1956; 4:20-34.

Van der Kooy K., and Seidell JC. Techniques for the measurement of visceral fat: a practical guide. *Int J Obes Relat Metab Disord* 1993; 17:187-96.

Vereecken CA, Maes L. A Belgian study on the reliability and validity of the health behaviour in school-aged children food-frequency questionnaire. *Public Health Nutr* 2003; 6: 581-88.

Voss S., Kroke A., Klipstein-Grobusch K., and Boeing H. Is macronutrient composition of dietary intake data affected by underreporting? Results from the EPIC-Potsdam Study. European Prospective Investigation into Cancer and Nutrition. *Eur. J. Clin. Nutr.* 1998; 52: 119–126.

Wake M., Hesketh K., and Waters E. Television computer use and body mass index in Australian primary school children. *J Paediatr Child Health* 2003; 39: 130–134.

Wang Y. and Wang JQ., A comparison of international references for the assessment of child and adolescent overweight and obesity in different populations. *Eur J Clin Nutr.* Oct 2002 ; 56: 973-82.

Waterlow J. et al. The presentation and use of height and weight data for comparing the nutritional status of children under age 10 years. *Bull WHO* 1977; 55(4): 489-498.

Wattigney WA., Harsha DW., Srinivasan SR., and Webber LS,Berenson GS. Increasing impact of obesity on serum lipids and lipoproteins in young adults: the Bogalusa Heart Study. *Arch Intern Med.* 1991; 151:2017–22.

Weinsier RL., Hunter GR., Desmond RA., Byrne NM., Zuckerman PA., and Darnell BE. Free-living activity energy expenditure in women successful and unsuccessful at maintaining normal body weight. *Am J Clin Nutr.* 2002;75:499–504.

Weiss R., Dziura J., Burgert TS., Tamborlane WV., Taksali SE., Yeckel CW., Allen K., Lopes M., Savoye M., Morrison J., Sherwin RS., and Caprio S. Obesity and the Metabolic Syndrome in Children and Adolescents. *N Engl J Med* 2004; 350: 2362-74.

Welton N. Statistical Methods In Biotechnology. Module Handbook. *University of the West of England, Bristol*, 1999.

Westerterp K., and Kester A. Physical Activity in Confined Conditions as an Indicator of Free-Living Physical Activity. *Obesity Research* 2003; Vol. 11 No. 7 July 865.

Whincup P., and Deanfield. Childhood obesity and cardiovascular disease: the challenge ahead. *Nature Clinical Practice Cardiovascular Medicine* 2005; 2: 432-433. www.nature.com/clinicalpractice/cardio

Whitaker RC., and Dietz WH. Role of the prenatal environment in the development of obesity. *J Pediatr.* 1998; 132: 768–76.

WHO. Reducing Risks, Promoting Healthy life. Geneva: *World Health Organisation* 2002.

WHO. Obesity – Preventing and Managing the Global Epidemic: Report of a WHO Consultation on Obesity. Geneva: *World Health Organization* 1998.

WHO. Energy and Protein Requirments. Report of a Joint FAO/WHO/UNU Meeting. Geneva: *World health organisation* 1985; Technical Report Series 724.

WHO Expert Committee. Physical Status: the use and interpretation of anthropometry. *World health organisation* 1995; Technical Report Series 854.

WHO. Preventing and Managing the Global Epidemic. Geneva: *World health organisation* 2000; Technical Report Series 894.

WHO. Global Strategy on Diet, Physical Activity, and Health. Geneva: *World Health Organisation* 2004; Resolution WHA 57.17.

Willett WC. Food Frequency Methods. *In Nutritional Epidemiology* 1998; Volume 5. 2nd edition. pp 74, Oxford University Press.

Wilson GT. Behavioral treatment of childhood obesity: theoretical and practical implications. *Health Psychology* 1994; 13: 371–372.

Wiseman MJ. Bognetti E., Dodds R., Keen H., and Viberti GC. Changes in renal function in response to protein restricted diet in Type 1 (insulin-dependent) diabetic patients. *Diabetologia* 1987; 30: 154-159.

Witschi J. Short-term dietary recall and recording methods. In: Wilter W, ed. *Nutritional Epidemiology*. New York, NY: Oxford University press; 1990:52-68.

Wolf AM., Colditz GA. Current estimates of the economic cost of obesity in the United States. *Obes Res* 1998; 6:97-106.

Wolf AM., and Colditz GA. Social and economic effects of body weight in the United States. *Am.J.Clin.Nutr.* 1996; 63:S466-9.

Wood N., Roger B., and Streckfus C. Comparison of body composition and periodontal disease using nutritional assessment techniques: Third National Health and Nutrition Examination Survey (NHANES III). *J Clin Periodontol* 2003; 30: 321–327.

Yamaguchi J., Oguni T., Konishi K., and Mino M. Abdominal adiposity with respect to the proportion of intra-abdominal visceral fat to extra-abdominal fat (V/S ratio) in Japanese childhood obesity. *Pathophysiology* 1996; 3: 29-35.

Zoumas-Morse C., Rock CL., Sobo EJ., and Neuhouser ML. Children's patterns of macronutrient intake and associations with restaurant and home eating. *J Am Diet Assoc* 2001; 101: 923–25.

Appendix 1

WRITTEN CONSENT FORM

TITLE OF INVESTIGATION: A study of health habits and food choice on the nutritional status and obesity risk in 6 – 13 year old school children in Kuwait

---

VOLUNTEER'S NAME (BLOCK CAPITALS):

ADDRESS:

TEL:

DATE OF BIRTH: GENDER: M / F

I have read the attached information on the research in which I have been asked for my child's participation and have been given copy to keep and a questionnaire to be filled down. I have had the opportunity to discuss the details and ask questions about this information. The Investigator has explained the nature and purpose of the research and I believe that I understand what is being proposed. I have been informed what the proposed study involves. I understand that the personal involvement and the particular data from this trial will remain strictly confidential. Only researchers involved in the investigation will have access. I hereby fully and freely consent to let my child to participate in the study, which has been fully explained to me. Also, I have been told that I will be informed if my child result was found abnormal. I understand that I am free to withdraw from testing my child at any time.

VOLUNTEER'S SIGNATURE: **DATE:**

As the investigator responsible for this investigation, I confirm that I have explained to the participant named above the nature and purpose of the research to be undertaken.

INVISTIGATOR NAME: Hasan F S Al-Shammari **SIGNATURE:**

If you are at all concerned about this, please contact:

Hasan F S AL-Shammari on 9082072 or e-mail: hsanam13@hotmail.com

Appendix 2

HEALTH HABITS AND HISTORY QUESTIONNAIRE

This form asks questions about your background, habits and food eating behaviour of Kuwaiti children aged between 6 to 13 years. The information you as parents and your child provide will help scientists to understand more about the factors which affect the health of school children. That knowledge would help us to plan a better environment and programmes to help improve their food intake, nutrition and health.

This form will take about thirty minutes to complete. The questions have been grouped into four categories. The first one on personal information relate to the family of subjects. Physical activity and leisure interests were grouped in section two. Section three is concerning food habits and behaviours, and the last section asking specifically to reveal influences on food habits of your child. A few questions may be similar to ones you have answered before but please let your child with your assistance, fill them all. If you are not sure about an answer, please estimate.

If you have any questions you would like to ask, please contact the researchers on ________________. We thank you for your time and contribution to this research.

Official Use code

SECTION ONE: General information about child and parents

SUBJECT NUMBER ☐☐☐☐☐☐☐☐ ----

Your AGE: is ☐ Years ----

Your GENDER: is (0)Male ☐ (1) Female ☐ ----

School ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐ ----

Governorate ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ----

1. How many other siblings live in your house?

a. None b. 1 – 3 c. 4 – 6 d. above 6 1 ---

2. What is the educational qualification of student father?

a. None b. Primary & intermediate

c. High School (secondary) d. University degree & above 2 ---

3. What is the educational qualification of student mother?

a. None b. Primary & intermediate

c. High School (secondary) d. University degree & above 3 ---

4. What is the net average monthly income of the family by K.D?

a. less than 250 b. 250 – 500 c. 501-750

d. 751 – 1000 e. More than 1000 4 --

<u>SECTION TWO:</u> The following questions are related to your child physical activity and leisure interests

5. How often does your child go to the school (≥ 4 days/week):

a. Walking b. By car 5 ---

6. Does your child undertake a walk to any outdoor/leisure centres

a. Never b. Sometimes (1-3 days/week) c. Always (≥ 4 days/week) 6 --

7. How many hours a day do you exercise?

a. Never b. ≤ 1 c. > 1 and < 2 d. ≥ 2 7 ---

8. What nature of exercise does your child prefer to perform?

a. Never b. Simple c. Medium c. Hard 8 ---

Examples of exercises nature:

- Simple: slow walking

- Medium or moderate: gentle cycling, and simple household chores
- Hard or vigorous: Swimming, volleyball, and football

9. Does your child enjoy during exercises, if he/she chooses the preferable type?
   a. Never b. Sometimes. c. Always 9 ---

10. Does your child enjoy playing with others, if he/she has chance?
    a. Never b. Sometimes c. Always 10 ---

11. Does your child exercise during hot weather?
    a. Never b. Sometimes. (1-3 days/week) c. Always (≥ 4 days/week) 11 ---

12. How many hours a day does your child watch TV and/or play computer games?
    a. Never b. ≤ 1 hour c. > 1 and < 2 hours c. ≥ 2 hours 12 ---

13. How many hours does your child sleep during school days?
    a. < 6 b. 6 to 8 c. > 8 and <10 d. > 10 13 ---

14. How many hours does your child sleep during holidays?
    a. < 6 b. 6 to 8 c. > 8 and <10 d. > 10 14 ---

<u>SECTION THREE:</u> The following questions are related to your child ood Habits and behaviors

15. Does your child eat at fixed times?
    a. Never b. Sometimes (1-3 days/week) c. Always (≥ 4 days/week) 15 ---

16. Does your child eat breakfast either in home or in school?
    a. Never b. Sometimes (1-3 days/week) c. Always (≥ 4 days/week) 16 ---

17. Does your child eat fast food (Macdonald's, Burger king, Hardeez, etc.)?

a. Never b. Sometimes c. Always 17 ---

(1-3 days/week) (≥ 4 days/week)

18. Does your child try to avoid fast food, such as Fried chicken, Hamburgers, Chips, etc?

a. Never b. Sometimes c. Always 18 ---

19. Does your child include vegetables (especially raw) in the meals?

a. Never b. Sometimes c. Always 19 ---

(1-3 times/days) (≥ 4 times/days)

20. Does your child eat without a real need to food?

a. Never b. Sometimes c. Always 20 ---

21. Does your child only eat while sitting at the dinner table or place?

a. Never b. Sometimes c. Always 21 ---

22. Does your child focus on what he/she is eating at mealtime and not TV, etc?

a. Never b. Sometimes c. Always 22 ---

23. Does your child like others to share with he/she in the food (e.g. brothers)?

a. Never b. Sometimes c. Always 23 ---

<u>SECTION FOUR:</u> The following questions are related to your child influences on food habits

24. Would your child like to have similar food that he/she saw on the TV?

a. Never b. Sometimes c. Always 24 ---

25. When your child is with friends, does he/she eat similar food?

a. Never b. Sometimes c. Always 25 ---

26. Does your child follow your (parents) suggestions for eating food?

a. Never b. Sometimes c. Always 26 ---

27. Does your child follow Doctor or Dietician plane for the diet, if any?

a. Never b. Sometimes c. Always 27 ---

28. Did your child get information about healthy food from others (schools, government programs, etc.)?

a. Never b. Sometimes c. Always 28 ---

29. Does your child like toys, which are introduced by fast food restaurants?

a. Never b. Sometimes c. Always 29 ---

Appendix 3

Modified Food Record Form (For Ages 6 to 13 years).
(Adapted and modified from the National health and Nutrition Examination Survey III CDC, U.S. Dept. of Health and Human Services, 1989).

Food Record Diary Form

Subject No.. Age (years)..........................

Height (cm) .... Weight (kg)...

Directions for Using the Food Diary

1 Keep your food diary current. This diary should be kept for a period of **ONE WEEK** and record each day's diary on a separate page. List all foods immediately after they are eaten.
2 Record **ONLY** one food item per line in this booklet.
3 Try to describe the food item to the best of your ability and include the amount.
4 Write down the brand name of any packaged food eaten e.g. **Walker's crisp (Salt and Vinegar Flavour).**
5 Report **only** the food portion that you actually ate.
6 You can record the food eaten using household measures e.g. **tablespoons, cups, slices of toast or raw apple.**
7 If you know how the food was prepared, please include it e.g. **fresh, toasted, frozen, baked, boiled, canned, smoked** etc.
8 For **canned** foods, please include the liquid in which it was canned e.g. **fruit cocktail in light syrup or tuna in water or pineapple in light syrup.**
9 **Do not try** to change your diet during the period you keep this diary.
10 Remember to record the **amounts of salad dressings, margarine, butter and oils, jam or marmalade** and other spreads you use.

The example below will help you complete your food diary

Time of Day	*Food Item and Method of Preparation*	Amount Eaten
7 am	Apple, raw, fresh	1 medium
7 am	Cereal, corn flakes (Kellogg's)	1 cup
	With sugar, white	2 teaspoonfuls
	With milk, skimmed	½ cup
11 am	Chocolate, (Kitkat)	1 bar
1 pm	Sandwich, tuna, mayonnaise	1 pack 2 slices
4 pm	Crisps, (Walkers)	1 pack (30 g)
7 pm	Fish, salmon, baked	10 oz.
7 pm	Rice, white, plain, boiled	1 small bowl

Subject No.................. Day One (Please indicate)................

Date.......................

Time of Day	Food Item and Method of Preparation	Amount Eaten

Appendix 4

Energy expenditure of various activities of moderate duration grouped according to physical activity ratio (PAR).

PAR 1.2 (1.0 - 1.4)

Laying at rest: reading

Sitting at rest: watching TV; reading; calculating; playing cards; listening to radio; eating.

Standing at rest.

PAR 1.6 (1.5 to 1.8)

Sitting: sewing; knitting; playing piano; driving.

Standing: preparing vegetables; washing dishes; ironing; general office and laboratory work.

PAR 2.1 (1.9 to 2.4)

Standing: mixed household chores (dusting and cleaning); washing small clothes; cooking activities; hairdressing; playing snooker; bowling.

PAR 2.8 (2.5 to 3.3)

Standing: dressing and undressing; showering; hovering; making beds:

Walking: 3-4 km/h; playing cricket;

Industrial: tailoring; shoemaking; electrical; machine tool; painting and decorating.

PAR 3.7 (3.4 to 4.4)

Standing: mopping floor; gardening; cleaning windows; playing table tennis; sailing.

Walking: 4-6 km/h; golf;

Industrial: motor vehicle repairs; carpentry, chemical; joinery; bricklaying.

PAR 4.8 (4.5 to 5.9)

Standing: polishing furniture; chopping wood; heavy gardening; volley ball.

Walking: 6-7 km/h:

Exercise: Dancing; moderate swimming; gentle cycling; slow jogging;

Occupational: labouring; hoeing; road construction; digging and shovelling; felling tress

PAR 6.9 (6.0 to 7.9)

Walking: uphill with load or cross-country; climbing stairs.

Exercise: average jogging; cycling.

Sports: football; more energetic swimming; tennis; skiing.

Source: the Committee on Medical Aspects of Food Policy (COMA) (Department of Health, 2003).

Appendix 5

Ministry of Health
Kuwait Institute for Medical Specialization
Research Unit

وزارة الصحة
معهد الكويت للاختصاصات الطبية
وحدة البحوث

CONSENT FORM

1. I, ..., the undersigned, hereby, agree to take part in the following research project:

   Project Title: ....

   Name of the Principal Investigator (P.I.): ....

2. I further confirm that I have read the letter "Information for participants" and that the following have been explained/provided to me:

   a. Aims of study.
   b. Methods used in study.
   c. Alternate (new) procedures or courses of treatment involved in the study.
   d. Expected duration of study.
   e. Number of participants in the study
   f. Confidentiality of my personal and medical information will be maintained.
   g. My rights as participant will be respected.
   h. Persons whom I can contact for further information.

3. I further acknowledge that I give my consent voluntarily without pressure from any person or authority and that I have the right to refuse or withdraw at any time without penalty or loss of benefit.

....

Signature of participant/ authorised representative | Signature of witness

Ministry of Health
Kuwait Institute for Medical Specialization
Research Unit

وزارة الصحة
معهد الكويت للاختصاصات الطبية
وحدة البحوث

إقرار بالاشتراك في بحث

١. أوافق أنا: .... الموقع أدناه، على الاشتراك في البحث التالي:
عنوان البحث: ....
اسم الباحث الرئيسي: ....

٢. كما أقر بأنني قد اطّلعت على كتاب " معلومات للمشتركين في البحث "، وأن الموضوعات الموضحة أدناه قد شُرِحت لي:

أ- أهداف البحث
ب- الطرق المستخدمة في البحث
ت- الطرق العلاجية البديلة(الجديدة) التي ستستخدم في البحث
ث- المدة المتوقعة للبحث
ج- عدد المشتركين في البحث
ح- المحافظة على خصوصية وسرية بياناتي الشخصية والصحية
خ- احترام جميع حقوقي كمشترك
د- اسم الشخص الذي يمكن الرجوع اليه للاجابة على أية استفسارات.

٣. كما أنني على دراية بأن موافقتي على الاشتراك في البحث اختيارية بدون أية ضغوط من أي شخص أو سلطة، كما أن لي الحق في الرفض أو الانسحاب من البحث في أي وقت دون التعرض لأية جزاءات أو حرمان من أية فوائد.

....
توقيع المشترك (أو من ينوب عنه)

....
توقيع الشاهد

التاريخ:...............................

Information for Participants

Researchers should explain explicitly the following points which participants are keen to know:

- Explanation of all the points stated in the "Consent Form"
- Methods which will be used and quantities of samples which will be collected from participants
- Description of any foreseeable risks or discomfort
- Description of expected benefits
- Assurance of participants that all their rights will be respected

معلومات للمشتركين في البحث

يتعين على الباحثين شرح الأمور التالية بطريقة واضحة، والتي غالبا ما يحرص المشتركين على معرفتها:

- شرح جميع النقاط المذكورة في " اقرار بالاشتراك في بحث "
- الطرق التي ستستخدم في البحث، مع ذكر العينات التي ستُجمع من المرضى وكمياتها
- المخاطر والمعاناة المتوقعة بسبب البحث
- الفوائد المتوقعة نتيجة البحث
- التأكيد على احترام جميع حقوق المشتركين في البحث.

Appendix 6

MINISTRY OF HEALTH
KUWAIT INSTITUTE FOR MEDICAL SPECIALIZATION
STUDIES AND RESEARCH UNIT

وزارة الصحة
معهد الكويت للاختصاصات الطبية
وحدة الدراسات والبحوث

Ref. : KIMS/17/1863
Date : 3-3-2003

الاشارة :
التاريخ :

To: Mr. Hassan Faleh Al-Shammari
Public Health Laboratories Department
Ministry of Health

From: Prof. Mohamed A.A. Moussa
Chairman, Medical Research Ethics Committee
Research Unit, KIMS

Prof Mohammed A A Moussa
Head Research Unit
Kuwait Institute for Medical Specialization

M. Moussa

Subject: Ethical decision on the research project: "A study of health habits and food choice on the nutritional status and obesity risk in 6-13 year old school children in Kuwait".

Decision of the Medical Research Ethics Committee:

Ethical permission granted.

Best wishes.

c.c.: Secretary General, KIMS

Behbahani Bldg - 8th Floor, Al-Sharq - P.O. Box 1793 Safat 13018 Kuwait
Tel : 2410029 - 2467380 - Ext. : 160 - Fax 2410028 - Telex MAKTABA 22720 KT
E-mail info@kims.org.kw - www.kims.org.kw

مجمع البهبهاني - الدور الثامن - الشرق - ص.ب ١٧٩٣ الصفاة 13018 الكويت
هاتف : ٢٤٦٧٣٨٠ / ١٦٠ - ٢٤١٠٠٢٩ - فاكس ٢٤١٠٠٢٨ - تلكس : مكتبا ٢٢٧٢٠ كويت

Appendix 7

Selected socio-demographic indicators of 1536 Kuwaiti school children* aged 6 – 13 years.

	Boys N	(%)	Girls N	(%)	Mean N	(%)
No. of siblings						
0 - 3	276	35.9	301	39.2	577	37.5
4 - 6	363	47.3	377	49	740	48.2
> 6	129	16.8	90	11.7	219	14.3
Parental Education						
Father:						
None	0	0	0	0	0	0
Primary/Intermediate	215	28	201	26.2	416	27.1
Secondary	278	36.2	337	43.9	615	40
University and above	275	35.8	230	29.9	505	32.9
Mother:						
None	22	2.9	12	1.6	34	2.2
Primary/Intermediate	114	14.8	137	17.8	251	16.3
Secondary	236	30.7	256	33.3	492	32.1
University and above	396	51.6	363	47.3	759	49.4
Net Monthly Family Income (KD)**						
< 250	101	13.2	75	9.8	176	11.5
250 - 500	112	14.6	155	20.2	267	17.4
501 - 750	298	38.8	281	36.6	579	37.7
751 - 1000	174	22.6	160	20.8	334	21.7
> 1000	83	10.8	97	12.6	180	11.7

* 23 schoolchildren (1.5%), 9 boys (0 6%) and 14 girls (0.9%), were excluded from the total number because inelligibility.
** 1 KD = 2 £

Appendix 8

Energy and nutrient composition of food intake (± SD and SEM) in relation to age, gender and body weight among 6 to 13 year old Kuwaiti school children.

Variables	Sex	6 years			7-10 years			11-13 years		
		Average	*SD*	*SEM*	*Average*	*SD*	*SEM*	*Average*	*SD*	*SEM*
Body weight (kg)	M	25.9	3.0	0.7	35.8	8.5	1.2	52.8	12.8	2.3
	F	26.7	3.9	1.1	38.8	7.7	1.1	51.6	8.7	1.4
Food weight (g)	M	1464.3	265.3	66.3	1467.7	251.9	35.3	1632.8	263.3	46.5
	F	1228.4	293.8	84.8	1430.8	293.7	42.8	1571.4	295.6	49.3
Food energy (kcal)	M	1903.3	325.9	81.5	2194.2	359.1	50.3	2408.8	375.3	66.3
	F	1696.5	274.9	79.4	1993.3	325.5	47.5	2255.4	420.3	70.1
Protein (g)	M	76.4	19.9	5.0	80.6	19.6	2.7	91.8	18	3.2
	F	73.0	15.0	4.3	87.6	14	2	100	20.8	3.5
SF (g)	M	29.5	8.6	2.2	32	7.3	1.0	39.6	9.4	1.7
	F	24.1	6.3	1.8	28	8.3	1.2	32.6	11.8	2
MUFA (g)	M	24.1	8.1	2.0	29	8.5	1.2	41	20	3.5
	F	20.5	6.0	1.7	25.2	6.6	1.0	29	6.6	1.1
PUFA (g)	M	10.3	3.6	0.9	11.7	3.5	0.5	16.6	5.1	0.9
	F	6.7	2.9	0.8	8.4	3.6	0.5	10.8	3.6	0.6
Total lipid-fat (g)	M	75.7	19.0	4.7	90.8	17.0	2.4	103	24.2	4.3
	F	70.7	17.0	4.9	79.9	16.1	2.4	95.4	20	3.3
T. carbohydrate (g)	M	230.3	34.6	8.7	254.5	55.2	7.7	271.2	48.7	8.6
	F	193.8	28.5	8.2	224.3	38.3	5.6	252.4	52.1	8.7
Calcium (mg)	M	698.2	138.7	34.7	642.2	181.5	64.3	775	189.8	28.6
	F	704.7	248.7	71.8	802.5	287.7	42	1006.8	316.7	52.8
Magnesium (mg)	M	330.7	56.5	14.1	336.7	51.9	7.3	407.1	77.3	13.7
	F	205.2	44.6	12.9	243.2	71.9	10.5	327.6	90.2	15
Iron (mg)	M	13.9	3.0	0.8	14.9	3.5	0.5	15.2	2.1	0.4
	F	10.5	2.3	0.7	12.8	2.8	0.4	16.7	4.1	0.7
Copper (mg)	M	2.5	0.5	0.1	2.4	0.5	0.1	1.9	0.7	0.1
	F	1.9	0.6	0.2	2.0	0.4	0.1	2.3	0.6	0.1
Selenium (µg)	M	84.1	21.6	5.4	82.8	25.2	3.5	111.4	35.5	6.3
	F	54.6	23.4	6.8	62.6	28.3	4.1	80.4	27.3	4.6
Ascorbic acid (mg)	M	55.2	31.8	7.9	69.7	45.4	6.4	46.4	29.5	5.2
	F	77.1	37.3	10.8	84.5	41.0	6.0	115.4	54.0	9.0
Folate (µg)	M	159.1	43.2	10.8	193.3	88.4	12.4	199.5	37.2	6.6
	F	124.4	55.5	16.0	153.4	69.1	10.1	233.3	87.1	14.5
Vitamin A (RE)*	M	411.9	66.2	16.5	444.8	164.2	23.0	594.8	167.3	29.6
	F	454.9	121.4	35.0	544.2	148.2	21.6	654.0	199.6	33.3

*RE: µg retinol equivalent/d (1 retinol equivalent = 1 µg retinol or 6 µg β-carotene). SF= Saturated fatty acids; MUFA= Mono-unsaturated fatty acid; PUFA= poly-unsaturated fatty acids; TF= Total fat

Appendix 9

Micronutrient intake among 6 to 13 year old Kuwaiti school children compared to UK Dietary reference values (DRVs) for selected vitamins and minerals (Department of Health, 2003).

Vitamins & Minerals	Current study*	RNI	EAR	LRNI
Vitamin A (RE)				
6 years	433.4	400	300	200
7-10 years	494.5	500	350	250
11-13 years	624.4	600	400	250
Folate (µg/d)				
6 years	141.7	100	75	50
7-10 years	173.3	150	110	75
11-13 years	216.4	200	150	100
Vitamin C (mg/d)				
6 years	66.1	30	20	8
7-10 years	77.1	30	20	8
11-13 years	80.9	35	22	9
Selenium (µg/d)				
6 years	69.3	20	-	10
7-10 years	72.7	30	-	16
11-13 years	95.9	45	-	25
Copper (mg/d)				
6 years	2.2	0.6	-	-
7-10 years	2.2	0.7	-	-
11-13 years	2.1	0.8	-	-
Magnesium (mg/d)				
6 years	267.9	120	90	70
7-10 years	289.9	200	150	115
11-13 years	367.3	280	230	180
Iron (mg/d)				
6 years	12.2	6.1	4.7	3.3
7-10 years	13.8	8.7	6.7	4.7
11-13 years:				
males	15.2	11.3	8.7	6.1
females	16.7	14.8	11.4	8.0
Calcium (mg/d)				
6 years	701.4	450	350	275
7-10 years	722.3	550	425	325
11-13 years:				
males	775.0	1000	750	480
females	1006.8	800	625	450

* Current subjects represent the average values of both genders together, except for the values of iron and calcium in age group 11-13 years, which were reported separately for each sex due to the DRVs availability by COMA.

Appendix 10

Subjects of current study body mass index (BMI) and sum triceps and subscapular (SFT) compared with three reference values of BMI and one reference values of skinfold thickness (SFT).

Sex & Age (yrs)	n	BMI				SFT	
		Current Study	*Mgbool**	*Cole***	*NCHS****	*Current Study*	*Frisancho*****
Males							
6	16	16.91	14.61	17.55	15.4	17.04	14.3
7	13	18.80	14.61	17.92	15.5	16.72	14.8
8	14	19.03	14.79	18.44	15.8	16.24	15.6
9	12	19.14	15.12	19.10	16.2	19.28	17.0
10	12	21.76	15.62	19.84	16.6	24.44	19.1
11	10	21.84	16.22	20.55	17.2	28.53	21.4
12	11	22.28	16.67	21.22	17.8	32.97	21.0
13	11	23.11	17.12	21.31	18.5	33.27	19.8
Females							
6	12	17.95	14.61	17.34	15.2	18.72	16.7
7	11	20.39	14.57	17.75	15.5	20.30	17.8
8	13	20.98	14.88	18.35	15.8	23.59	20.0
9	12	21.98	15.36	19.07	16.3	27.61	22.4
10	11	22.07	15.75	19.86	16.9	28.55	23.6
11	12	22.46	16.83	20.74	17.5	29.33	25.5
12	12	22.49	18.26	21.68	18.1	32.28	26.6
13	12	23.45	19.09	22.58	18.7	34.61	28.7

*Magbool, 1994, **Cole *et al.*, 2000, ***NCHS-CDC reference population, and ****Frisancho, 1990.